Faculty of Computer Science and Information Technology, University of Malaya

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A Computer-Aided Learning Package for Chinese Calligraphy

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Abstract

One of the most rapidly changing and exciting areas of learning in the world today is the development of computer-based learning materials, especially interactive learning programs that run on personal computers. These programs offer users a brand new experience in the learning world. Through the condensed storage capabilities of computers, multimedia can deliver large amounts of information in ways that make it manageable, approachable and useful. By making it possible to access illustrations and photographs, sound and video, as well as large amounts of text, interactive multimedia programs present learning information to users in a newly engaging and meaningful way.

This report presents the development of a courseware, which aims to build a computer-aided learning package for Chinese calligraphy. (CHICALEP). This learning package is developed for any users from all ages who wish to learn Chinese calligraphy.

The prototyping approach was selected for the development process because it supports Rapid Application Development (RAD) and reduces the risks involved. Software engineering principles based on this approach were applied throughout the development phases of system analysis, system design, implementation, evaluation and testing.

Main functions included in this package are introduction and historical evaluation of Chinese Character, structures of Chinese character, four precious tools of Chinese calligraphy, different levels of exercise and assessment, assessment results, maintenance and help.

This package was developed using combination of graphic tool, multimedia tool, language tool and programming tools which included Adobe® Photoshop® 7.0, Macromedia Flash MX Version 6.0, Chinese Star XP, and Microsoft® Visual Basic 6.0.

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List of Abbreviations

ADPCM	Adaptive Differential Pulse Code Modulation
AMD	Advanced Micro Devices
CAL	Computer-Aided Learning
DBMS	Database Management System
DFD	Data Flow Diagram
GUI	Graphic User Interface
HTML	Hyper Text Markup Language
JPEG	Joint Photographic Expert Group
MP3	Motion Picture Experts Group Layer 3
PNG	Portable Network Graphic
RAD	Rapid Application Development
RAM	Random Access Memory
SDLC	System Development Life Cycle
SWF	Shockwave Flash
WIA	Windows Image Acquisition
WMA	Windows Media Audio
WYSIWYG	What You See Is What You Get

Chapter 1: Introduction

1.1 Project Overview

Computer-Aided Learning (CAL) refers to the application of learning tools that use the computer technologies to assist people in the study or learning process. This project aims to develop an interactive Chinese calligraphy learning package, known as CHICALEP, for users from all ages. It is a standalone system, which can be run by installing the system from the CD-ROM into a personal computer. CHICALEP is a bilingual system that can be viewed using both English and simplified Chinese (GB2312). It consists of four main modules:

a) Introduction

b) Exercise and assessment

c) Maintenance

d) Help and manual

Introduction module provides knowledge about Chinese calligraphy and the remaining modules promote the learning interest of the users throughout a step-by -step learning process.

1.2 Project Objective

This project aims to introduce and promote the interest of users from all ages in Chinese calligraphy. The main objective of this project is to develop a bilingual computer-aided learning package to assist users in the learning of Chinese calligraphy. This package aims to:

a) Introduce Chinese calligraphy to the general public.

b) Promote the interest of the general public in the learning of Chinese calligraphy via an easy-to-follow learning process. It also enables a step-by-step learning process that based on user's learning pace.

c) Improve the writing of a user's skill in Chinese calligraphy.

d) Help create a gentle and calm emotion via the writing of Chinese calligraphy.

1.3 Project Scope

The scopes of this project are:

a) Develop a bilingual system that enables a user to learn Chinese calligraphy in either Chinese or English language.

b) The learning package should provide the following four main functions:

i) *Introduction to Chinese Calligraphy*

This section describes the history of Chinese calligraphy, types of Chinese calligraphy handwriting, famous calligraphers, artists and the calligraphy writing tools.

ii) *Exercises and Assessment*

The exercise and assessment is divided into three parts:

- ✓ Elementary level

  Learn Chinese character with one to five strokes.

- ✓ Intermediate level

  Learn Chinese character with six to ten strokes.

- ✓ Advanced level

  Learn Chinese character with more than ten strokes.

iii) *Assessment Result*

This module displays assessment result of the current user.

iv) Maintenance

Allow the user to change his password and allow the system administrator to add new Chinese characters into the system database.

c) The learning package shall store Regular, "Wei", and Official characters for the elementary, intermediate and advanced levels, respectively in the system database.

1.4 Project Expectation

As many other projects, certain expectation of the outcome are projected before the real work begin. These expectations are made taking into the account the technologies available as well as the amount of time available to complete the project. The expectation of this project is to produce a bilingual computer-aided learning package for Chinese calligraphy by accomplishing the following tasks:

a) Design and implement all the modules in CHICALEP

b) Design and implement the system database for CHICALEP.

c) Design and store all sample images and SWF files for CHICALEP.

1.5 Project Schedule

1.5.1 Gantt Chart

The Gantt chart was developed during the early 1900s by Henry Gantt. The idea behind a Gantt chart is simple. It is essentially a bar graph, with time on the horizontal axis and the activities to be scheduled on the vertical axis. The bars show the output, both planned and actual, over a period of time. The Gantt chart visually shows when the tasks are supposed to be done and compares that with the actual progress on each. It is a simple but important device that details easily what has yet to be done to complete a job or project and assess whether an activity is ahead of, behind, or on scheduled [Robbin; Coulter, 1999].

This project was carried out through the period from the beginning of July, 2003 until the middle of February, 2004. The development progress is shown in Figure 1.1.

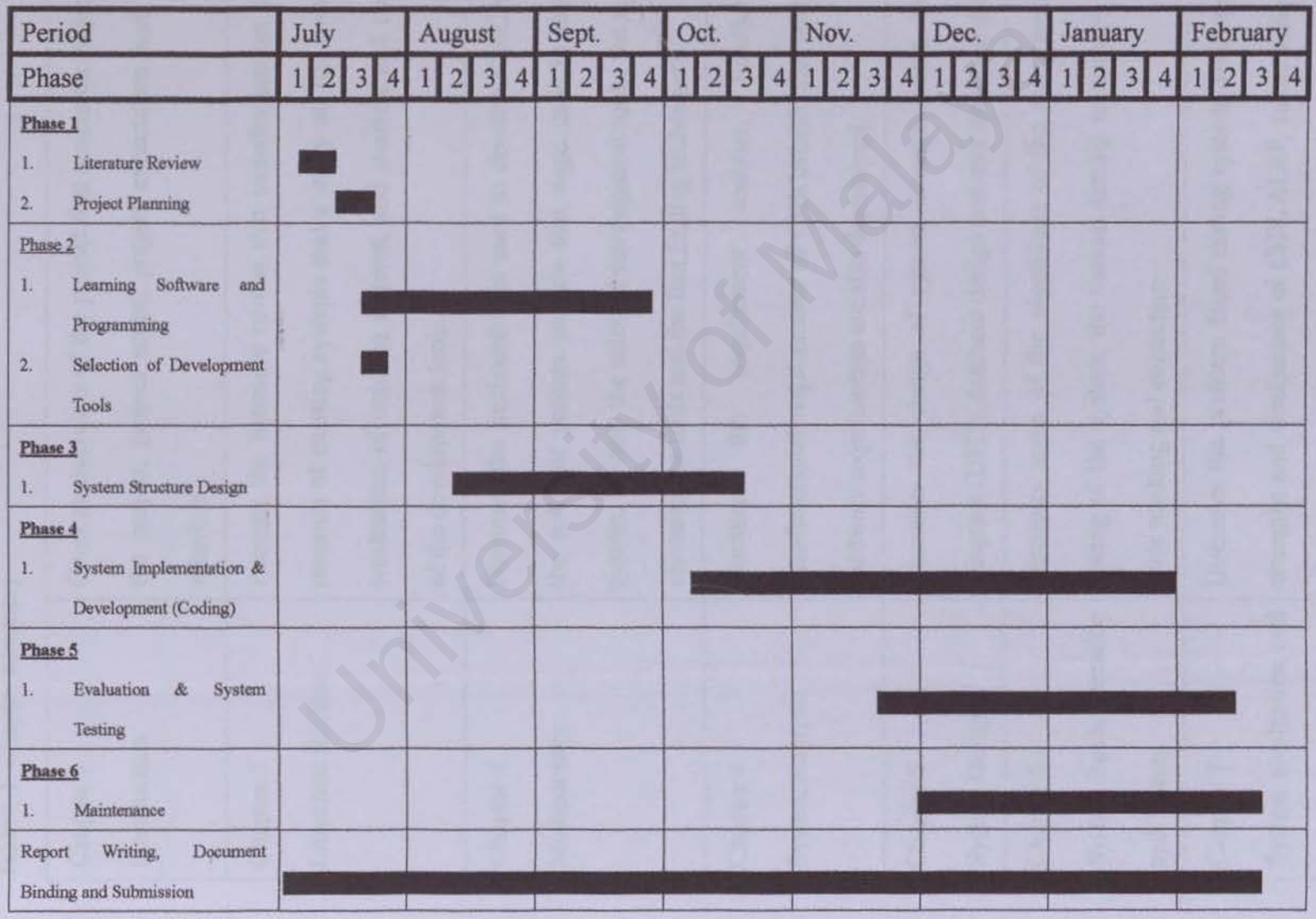


Figure 1.1: Gantt Chart of CHICLEP

1.6 Chapter Summary

Table 1.1: Chapter summary

Chapter 1 Introduction	Gives an overview of the project that covers the objective of the project, project scope, project expectation and project schedule.
Chapter 2 Literature Review	Presents the literature review that includes project definition, research of existing systems and a study on the strengths and weaknesses of existing systems, and analysis and comparison of the development tools.
Chapter 3 Methodology	Discusses the methodologies used to develop CHICALEP and the software process models that were used to develop the system. Review the selected development tools, the reasons for choosing the tools and the fact finding techniques.
Chapter 4 System Analysis	Discusses the requirement analysis, functional and non-functional requirements of CHICALEP. The software and hardware requirements are also determined.
Chapter 5 System Design	Discusses the design of system structure chart, Data Flow Diagram (DFD), database design and user interface design.
Chapter 6 System Implementation and Testing	Discusses some of the algorithms of the main modules, the coding of the system, the various testing techniques used and error tracking and correction.
Chapter 7 System Evaluation and Conclusion	Discusses the problem faced during system development, the strengths and weaknesses of CHICALEP, future enhancements of CHICALEP, the application and usefulness of CHICALEP.

1.7 Summary

This chapter gives an overview of the project which covers the project objectives, scopes, expectations, and schedule of the project. The main modules of CHICALEP are identified and defined clearly.

Chapter 2: Literature Review

Literature review was conducted to collect materials on various issues related to this project. A few areas are covered in this section but mostly focused on what computer-aided learning is all about as well as a quick view at the tools that will be used to build CHICALEP.

2.1 Computer-Aided Learning (CAL)

Computer-Aided Learning (CAL) describes a learning environment where a computer program is integrated to teach a particular subject, after re-assessment of current teaching method. The CAL is not only a single computer program, but it also can be interpreted as an art of education strategy devised to teach a particular subject [Reynolds, 1996].

2.1.1 Computer-Aided Learning (CAL) Elements

CAL sequences consist of the following elements [Ahmad, 1985]:

a) Text material

A short module or section is prepared which includes explanatory materials.

b) Test questions requiring user's response

After reading the text module, a user is required to answer questions on the lesson or materials that he just learned. The system analyses the response, and correct answers are reinforced with expressions of approval.

c) Additional backup instruction material

If a user has difficulty with the original text, alternative explanatory materials on the same subject are displayed. These alternatives shall be in animation, voice instruction or video clip.

d) Analysis of progress

At the end of the lesson, the user is provided with a progress report, indicating subjects mastered, the percentage of correct response and subjects requiring further attentions.

2.1.2 Method of Instruction

Computer-Aided Learning (CAL) includes various modes of instruction. These modes are not mutually exclusive. However, an individual program can employ aspects of several modes at one time. These modes are [Stern and Robert, 1983]:

a) *Tutorial mode*

In this mode, information is presented in small units or modules followed by a question. The computer analyses the user's response and appropriate feedback is given.

b) *Drill and practice mode*

This mode leads the user through a series of examples, problems or exercises to increase dexterity and fluency of a concept, rule or procedure which was taught to the user.

c) *Discovery and problem solving mode*

The aim of this mode is to deepen understanding that results from grappling with a puzzling problem. In using the discovery mode, the computer program presents to user with sources of information, stores data and provides facilities for information retrieval from a database. The program will monitor the user's progress. User makes hypotheses, test guesses, develops principles and draws conclusion. Finding answers usually required high-level thinking skills such as

predicting, inferring and estimating. Problem solving involves a user's ability to integrate what is learned with his knowledge base.

d) Game and simulation mode

Game provides the opportunity for user to receive instruction in a motivating format. A routine instruction can become alive when presented as a game. Simulation is a dynamic representation of a real object, situation or environment. Computer simulations focus on cognitive strategies by putting the user in an active role, process input, makes decisions, monitor progress and coordinate efforts to reach a goal.

2.1.3 When Computer-Aided Learning (CAL) is Worth Considering

Computer-Aided Learning (CAL) offers potential advantage for general training in the following circumstances [Dean and Whitlock, 1993]:

a) Fairly small numbers of people need training over an extended period.

b) Large numbers of people need training frequently.

c) User with widely differing starting skills need to attain the same level of finishing skill.

d) Certain topic need to be taught to all personnel, at all levels of seniority.

e) Travel and accommodation cost are high.

2.2 Chinese Calligraphy

Chinese calligraphy (Brush calligraphy) is an art unique to Chinese cultures. "Qin" (a string musical instrument), "Qi" (Chinese chess game), "Shu" (calligraphy), and "Hua" (painting) are the four basic skills and disciplines of the Chinese literati [Asiawind.com, 2004].

Regarded as the most abstract and sublime form of art in Chinese culture, "Shu Fa" (calligraphy) is often thought to be most revealing of one's personality. Unlike other visual art techniques, all calligraphy strokes are permanent and incorrigible, demanding careful planning and confident execution. Such are the skills required for an administrator / executive. While one has to conform to the defined structure of words, the expression can be extremely creative. To exercise humanistic imagination and touch under the faceless laws and regulations is also a virtue well appreciated [Asiawind.com, 2004].

By controlling the concentration of ink, the thickness and adsorptive power of the paper, and the flexibility of the brush, the artist is free to produce an infinite variety of styles and forms. To the artist, calligraphy is a mental exercise that coordinates the mind and the body to choose the best styling in expressing the content of the passage. It is a most relaxing yet highly disciplined exercise indeed for one's physical and spiritual well being [Asiawind.com, 2004].

2.3 Graphic User Interface

2.3.1 Definition

A software interface is the part of an application that the user uses and interacts with. It is related to, but not the same as, the underlying structure, architecture, and one that makes the software work. The interface included the screen, windows, controls, menus, metaphors, online help, documentation, and training. Anything the user sees and interacts with is part of the interface [Weinschenk, 1997].

2.3.2 Intelligent Interface Design

An intelligent interface is an easy to learn and use interface. It allows user to do their work or perform a task in the way that makes the most sense to them, rather than having to adjust to the software. An intelligent interface is specially designed for the people who will be using it. It maximise what we know about human strengths, such as analysis and decision-making. It takes the environment, task and experience of the place using the product into account in its design. Well-designed interface reduces errors, training time, and cost, make people more productive, and result in superior customer service [Weinschenk, 1997].

2.4 System Study : System Developed By FCSIT Undergraduates

Prior to developing CHICALEP, a study on the existing learning packages was conducted to review the features, strengths and weaknesses of these packages. A review on five past year learning package projects, for the past three years (1999-2001) was conducted. These packages are reviewed a comparison on their features, strengths, and weaknesses was made so that good and suitable features of these packages can be considered and incorporated into CHICALEP.

Table 2.1 Comparison of Past Year Learning Package Projects.

Year	Project Title	Project Description	Comments	Development Tools used
1999 / 2000	ALPS – SPM Physics Learning Package	Consist of all the details for SPM Physics Paper I, included trial exam and exercise.	Very comprehensive GUI, with text speech engine.	V.B. 6.0, Macromedia Flash, Access
2000 / 2001	Computer Aided Learning for Chinese Phonetics	To assist primary school students to learn Chinese Phonetics.	Looks good GUI but too little features.	V.B. 6.0, Access

2000 / 2001	Computer Aided Learning Package for C#	Introduces the programming language C#.Net to users.	No comment	Macromedia Director
2000 / 2001	M-Sign	Help the user to learn Malaysian's sign language.	Simple GUI, with a exercises but poor sound implementation.	V.B. 6.0, Macromedia Flash, Access

2.5 Development Tools Review

In this section, a review and comparison on a few of the programming and language tools was conducted. The selected tools are discussed in more detail in Chapter 3.

2.5.1 Programming Tools Review

The programming tools are the main tools used to develop CHICALEP. These tools must:

a) Enable the development of Windows applications which work well with database.

b) Be able to create a high impact and good quality graphical user interface.

A few programming tools are available and are considered to be used as the main programming tools for CHICALEP. These tools included:

a) Microsoft® Visual C++ 6.0

b) Microsoft® Visual Basic 6.0

c) Java™

2.5.1.1 Microsoft® Visual C++ 6.0

Microsoft® Visual C++ 6.0 provides a graphical integrated development environment for creating two types of C++ programs [Bronson and Gary, 2000]:

a) Console application

This is a traditional character-based program that runs under non-Windows based operating systems such as DOS or UNIX.

b) Event-driven program

This is a graphical-based program that is highly dependent on user interaction such as press a button or click on a checkbox.

2.5.1.2 Microsoft® Visual Basic 6.0

Microsoft® Visual Basic 6.0 (VB6) is an event-driven programming language, where the codes are executed as a respond to an event. VB6 also enables the developer to create applications in Rapid Application Development (RAD) environment [Neito, 1998].

With this visual programming environment, the developer had the ability to create graphical user interfaces (GUIs) by pointing and clicking with mouse. Visual programming eliminates the need for the developer to write codes that generate the codes for all forms' properties, codes for form placement on the screen, codes to create and place a tree view on the forms, codes to change the image and text, etc. All of these codes are provided by Microsoft® Visual Basic 6.0. The developers create the GUIs and write codes to describe what happen when the user interacts (click, press a key, double click, etc.) with the GUIs. These notifications, called events, are passed by Microsoft® Windows operating system [Neito, 1998].

Event procedures are Visual Basic procedures that response to event and automatically generated by Visual Basic. The programmer adds codes to response to specific event. Only events that are relevant to a program need to be coded [Neito, 1998].

2.5.1.3 Java™

The Java™ platform realised the idea that the same software should be able to run on any different kinds of computer, consumer gadgets, and other devices. Any Java™ applications can easily be delivered over the Internet, or any network, without operating system or hardware platform compatibility issues [Sun Microsystems Corp., 2002].

Java™ is a complete object-oriented language that based on C++. It was developed by Sun Microsystems in 1991. It can be used to develop standalone applications as well as Web applets [Sun Microsystems Corp., 2002].

Java™ is very similar to C++, but takes out a lot of complexities of C++. This makes its program significantly smaller and less complex than C++ programs. Program made by Java™ is platform independent, which mean its program can run at any operating platform, either Windows, Mac®, or Solaris [Sun Microsystems Corp., 2002].

Table 2.2: Comparison of Programming Tools

Features	Microsoft® Visual C++ 6.0	Microsoft® Visual Basic 6.0	Java™
Platform independency	No	No	Yes
Speed of application developed	Fast	Satisfactory	Slow
Documentation	Good	Plenty	Poor
Popularity	Yes	Yes	Yes
Cost of purchase	High	High	Free
Ease-of-use	Intermediate to Advanced	Easy to Intermediate	Intermediate

2.5.2 Language Tools Review

A numbers of Chinese language software were considered prior to the development of CHICALEP. These tools include Chinese Star XP, MagicWin98 Version 1.3f, and NJ Star Communicator 2.31 as shown in Table 2.3 [Chinese Star XP, 2004; MagicWin98, 1998; NJStar, 2003].

Table 2.3: Comparison of Chinese Language Software

	Chinese Star XP	MagicWin98 Version 1.3f	NJ Star Communicator 2.31
Supported OS	Microsoft® Windows 2000 / XP	Microsoft® Windows 3.x/95/98/ME only	Microsoft® Windows 95/98/ME/NT/2000/ XP
Supported Language Encoding	**Chinese** : GB2312 and BIG5 only	**Chinese**: GB, GBK, BIG5, HK GCSS, Unicode UTF7 & UTF8 **Japanese**: Shift JIS, EUC JIS, JIS, Unicode UTF7 & UTF8 **Korean**: KSC. Unicode UTF7 & UTF8	**Chinese**: GB, GBK, BIG5, Unicode, UTF8/UTF7, HZ-8, HZ-7, ISO-2022, MIME **Japanese**: Shift-JIS, EUC-JIS, New-JIS, Unicode, UTF8/UTF7, ISO-2022, MIME **Korean**: KSC, Unicode, UTF8/UTF7, ISO-2022, MIME
Input Method	Yes. Integrated with "Chang Jie", "Shuang PinYin", "New PinYin", 5 Stroke, Big 5, "ZhuYin" and etc.	No input method	Yes. Integrated with "Double PinYin", "Standard PinYin", 5 Stroke, Big 5, "ZhuYin", "Chang Jie" and etc.

Supported software	Office 2000 / XP. Internet Explorer 4.0/5.5/6.0, Netscape 4.0 or higher, Adobe® Photoshop 5.5/6.0/7.0. Macromedia Dreamweaver 4.0, MSN Explorer, MSN Messenger, ICQ. C++, FoxPro, Visual Basic	Office 97, Netscape Communicator 4.x and Internet Explorer 4.x	Office 97/2000/XP Netscape Communicator 4.x or higher, Internet Explorer 4.0/5.0/6.0
Special Font	Yes. Contain more than 5 and up to 17 type of new Chinese true type font.	No additional font.	No additional font.
Graphic User Interface	Good	Good	Good
Language Detection	Manually change.	Smart detection and change automatic	Smart detection and change automatic
Special Features	Chinese Star Intelligent Sentence Recognition II, "Crazy PinYin II", Text Encode Converter, integrated with "Font Creator" and "Art Font".	Can save encoding scheme for applications	Universal Code Converter can convert files or clipboard content to any supported encoding, also can save the content as GIF picture file.

2.5.3 Database Tools Review

2.5.3.1 Microsoft® Access XP

Database Management System (DBMS) is defined as a software system that enables users to define, create, maintain, and control access to the database [Connolly and Begg, 2002].

Microsoft® Access XP is the most widely used relational DBMS for Microsoft® Windows operating system. It is a typical PC-based DBMS capable of storing, sorting, and retrieving data for a variety of applications. It provides a graphic user interface to create tables, queries, forms, and reports [Connolly and Begg, 2002].

Microsoft® Access XP provides "Wizards" to simplify many of the processes of building a database application by taking the user through a series of question-and answer dialog boxes [Connolly and Begg, 2002].

2.5.4 Multimedia Tools Review

2.5.4.1 Macromedia Flash MX

Macromedia Flash MX is the standard for interactive vector graphics and animations, especially for the Web. Macromedia Flash MX can create beautiful, resizable and extremely compact navigation interface, technical illustrations, long-form animation, and other dazzling effects. It also provides high quality viewing for graphics and animations [FlashMX1, 2004; FlashMX2, 2004].

The advantages using Macromedia Flash MX are as follow [FlashMX1, 2004; FlashMX2, 2004]:

a) Universal deployment

Delivers high-fidelity content regardless of OS and client hardware specifications. Applications can run on Windows®, Macintosh®, and Unix® operating systems, and on the Web, PDAs, and even cell phones.

b) Compactness

i) SWF files created are extremely small, even though the animation is set to full screen playback.

ii) Minimises network bandwidth requirement.

c) *Flash supports animation and image*

i) Supports timelines, which enable the creation of both simple and complex paths and sprite-base animation sequences.

ii) Supports most of the image formats (JPEG, BMP, TIFF, PNG). Flash also supports bitmap interpolation or smoothing to retain quality when an image is scaled or rotated.

d) *Audio support*

Incorporates high-fidelity audio with support for AIFF, WAV, MP3, WMA, ADPCM, and Nelly Mosser codec, and playback control over volume and pan settings.

2.6 Summary

In this chapter, some related materials of this project such as CAL and Chinese calligraphy have been reviewed. A review of the past year projects also have been done to compare the strengths and weaknesses of these systems. All the development tools that are considered suitable to be used to develop CHICALEP have been investigated.

Chapter 3 Research Methodology

3.1 Introduction

In this chapter, several development methodologies are reviewed and the selected methodology to be used is the prototyping model. The chapter discusses the reasons for choosing this methodology, the selected development tools which include the programming and Chinese language tools, and the fact finding techniques used.

3.2 System Development Life Cycle

A system development life cycle (SDLC) model is one of a number of structured approaches to information system development, created to guide all the processes involved, from an initial feasibility study through maintenance of the completed application. SDLC approaches include the waterfall model - the original SDLC method; Rapid Application Development (RAD); Joint Application Development (JAD); the fountain model; the spiral model and etc. Frequently, several models are combined into some sort of hybrid process. Documentation is crucial regardless of the type of model chosen or devised for any application, and is usually done in parallel with the development process [SDLC, 2003].

In general, an SDLC model follows the following steps [SDLC, 2003]:

a) The existing system is evaluated. Deficiencies are identified. This can be done by interviewing users of the system and consulting with support personnel.

b) The new system requirements are defined. In particular, the deficiencies in the existing system must be addressed with specific proposals for improvement.

c) The proposed system is designed. Plans are laid out concerning the physical construction, hardware, operating systems, programming, communications, and security issues.

d) The new system is developed. The new components and programs must be obtained and installed. Users of the system must be trained in its use, and all aspects of performance must be tested. If necessary, adjustments must be made at this stage.

e) The system is put into use. This can be done in various ways. The new system can be phased in, according to application or location, and the old system gradually replaced. In some cases, it may be more cost-effective to shut down the old system and implement the new system all at once.

f) Once the new system is up and running for a while, it should be exhaustively evaluated. Maintenance must be kept up rigorously at all times. Users of the system should be kept up-to-date concerning the latest modifications and procedures.

3.2.1 Waterfall Model

"Waterfall Model" is a software life cycle or product life cycle model, described by, in which development is supposed to proceed linearly through the phases of requirements analysis, design, implementation, testing (validation), integration and maintenance [Royce, 1970].

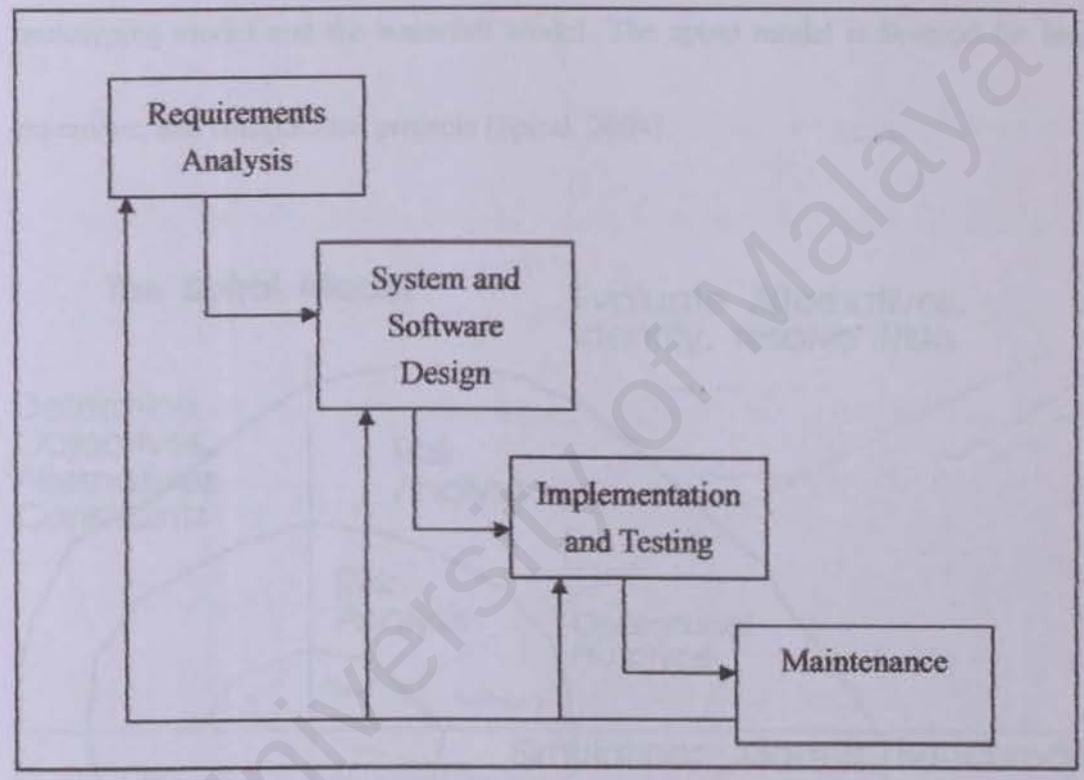


Figure 3.1 : Waterfall Model

3.2.2 Spiral Model

The spiral model is a software life cycle model in which supposes incremental development, using the waterfall model for each step, with the aim of managing risk. In the spiral model, developers define and implement features in order of decreasing priority [Boehm, 1986]. This model of development combines the features of the prototyping model and the waterfall model. The spiral model is favored for large, expensive, and complicated projects [Spiral, 2004].

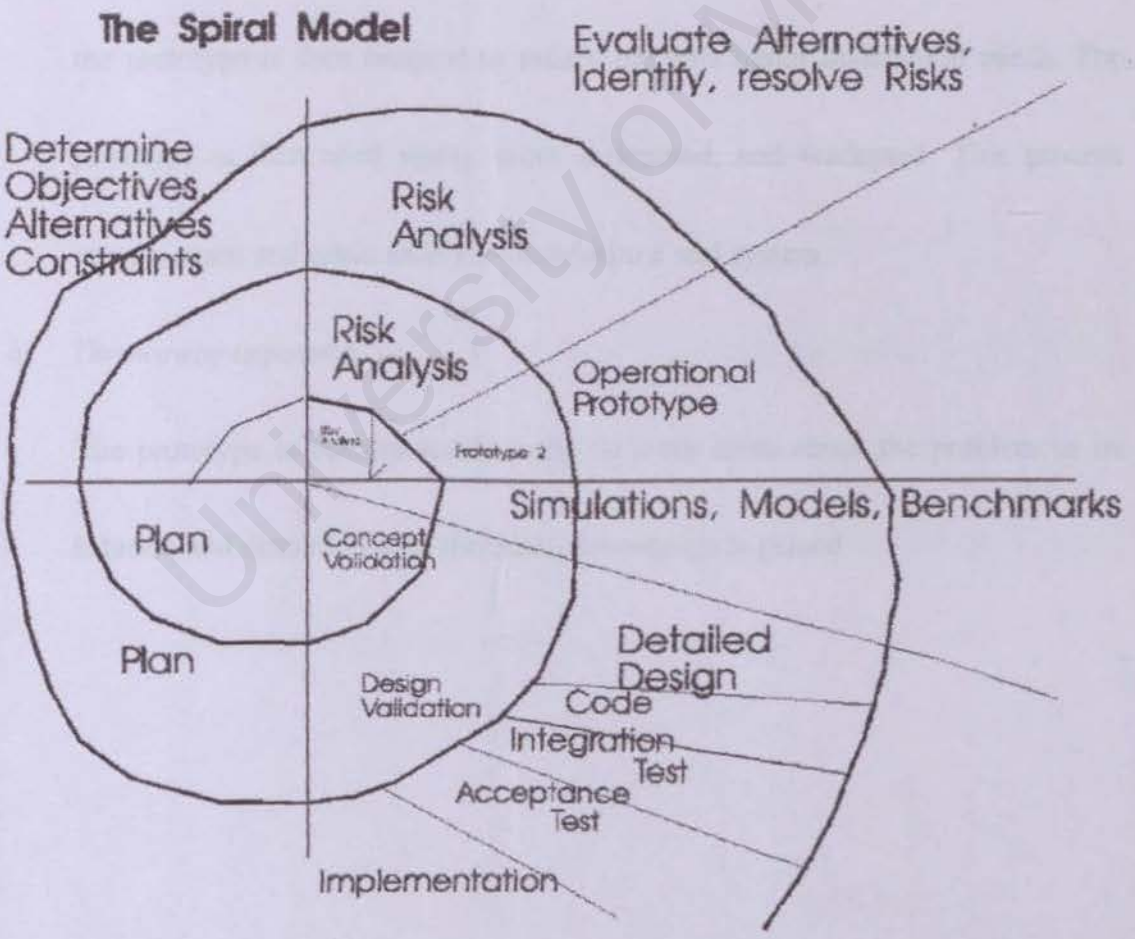


Figure 3.2 : The Spiral Model [grok.ecn.uiowa.edu, 2004]

3.2.3 Prototyping

Prototyping is the technique of constructing a partial implementation of a system so that customers, users, or developers can learn more about a problem or a solution to that problem [Davis, 1993]. There are two types of prototyping approach [Davis, 1993]:

a) Evolutional approach

The prototype is constructed in order to learn more about the problem or its solution; once the prototype has been used and the requisite knowledge gained, the prototype is then adapted to satisfy the now better understood needs. The prototype is then used again; more is learned, and readapted. This process repeats again and again until it evolved into a real system.

b) Throwaway approach

The prototype is constructed in order to learn more about the problem or its solution and discarded after the desire knowledge is gained.

3.3 Selected Methodology

From those models discussed above, evolutional prototyping approach has been selected as the development methodology to develop CHICALEP. The reasons are [Stair, 1996]:

a) *High level of user involvement throughout the development process.*

With this approach, developers and users can see and work with the output from each subsystem or component as it is being developed.

b) *Fast development time.*

It takes only a few weeks or months to obtain meaningful results, compared to years for the complete system to be operational.

c) *Fewer and less costly errors and omission.*

Prototyping allows errors and omissions to be detected earlier in the SDLC. Without prototyping, errors may not be detected until later in the development process. The later in the development process those changes are made, the more time consuming and expensive these changes become.

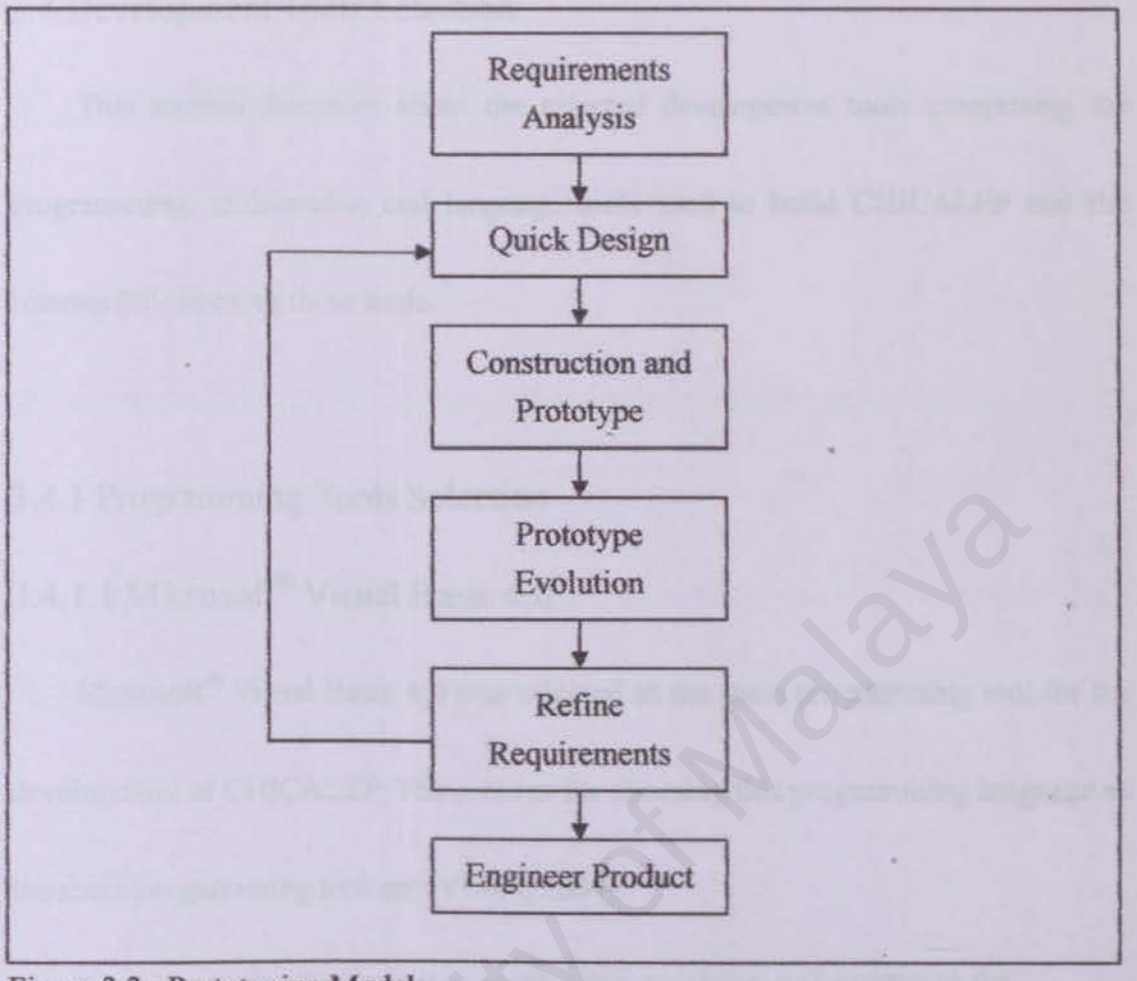


Figure 3.3 : Prototyping Model

3.4 Development Tools Selection

This section discusses about the selected development tools comprising the programming, multimedia, and language tools used to build CHICALEP and the reasons for choosing these tools.

3.4.1 Programming Tools Selection

3.4.1.1 Microsoft® Visual Basic 6.0

Microsoft® Visual Basic 6.0 was selected as the main programming tool for the development of CHICALEP. The reasons for choosing this programming language as the main programming tool are [VB6.0, 2004]:

a) It has a rich set of control that enables fast development of CHICALEP.

b) It is a visual WYSIWYG designer for Windows form.

c) Provide easy access to database through ActiveX® Data Object (ADO).

d) Has a native code compiler and debugging tools that build native code applications and components that make use of the world-class Visual C++® compiler technology.

3.4.2 Multimedia Tool Selection

3.4.2.1 Macromedia Flash MX

This software package was selected as the multimedia tools for the project because [FlashMX1, 2004; FlashMX2, 2004]:

a) It can create beautiful, compact and resizable animations and graphics.

b) It can provide high quality sound and graphics.

c) Capability to be imported by Visual Basic 6.0 by using Shockwave Flash Control for multimedia flash.

3.4.3 Language Tool Selection

3.4.3.1 Chinese Star XP

Chinese Star XP was selected as the default language tool for the development of CHICALEP because [Chinese Star XP, 2004]:

a) It has a better compatibility with Windows 2000 and XP compare to the other two. Its performance in viewing Chinese character is also better than other Chinese language software.

b) Various Chinese true type fonts are available to build various writing style Chinese character.

c) Better software support.

3.4.4 Database Tool Selection

3.4.4.1 Microsoft® Access XP

Microsoft® Access XP was selected as the main database tool to build a database to support CHICALEP because CHICALEP is a small scale application. It only requires a small scale database to support it. There is no need to select large scale DBMS like SQL Server 2000.

3.5 Fact Finding Techniques

Fact finding is the formal process of using techniques such as interviews and questionnaires to collect facts about systems, requirements, and preferences. It is partially crucial to the early stage of the lifecycle including the database planning, system requirements, requirements collection and analysis stages [Connolly and Begg, 2002].

3.5.1 Internet Surfing

At the current stage, it is believed that Internet is the world biggest and the most complete information database. Most of the information can be viewed from the Website in Internet but the information gathered is not 100 percent reliable. Through this technique, the historical information of Chinese Calligraphy is found on several Websites as follow:

a) *http://www.chinavoc.com*

b) *http://www.wavedancing.net*

c) *http://www.asia-art.net/*

d) *http://www.chinapage.com/callig1.html*

e) *http://www.asiawind.com/art/callig/Default.htm*

f) *http://chineseculture.about.com*

3.5.2 Market Survey

This technique was applied to investigate similar computer-aided learning package that are available in the local software market and from the bookstores. The investigations on the similar packages include reviews on the strengths and weaknesses of the existing similar software packages, and its main features usefulness.

3.5.3 Reviews on Past Years' Project Reports

To get a clearer picture of the learning package to be developed, a few past year undergraduate and master project report which are related to this project were reviewed.

Table 3.1 : List of Past Year Project Report Reviewed

Year	Title	Degree
1999 / 2000	ALPS – SPM Physics Learning Package	Undergraduate
2000 / 2001	Computer-Aided Learning Package for Chinese Phonetics	Undergraduate
2000 / 2001	Computer-Aided Learning Package for C#	Undergraduate
2000 / 2001	M-Sign – A Computer-Aided Learning Package for Malaysian Sign Language	Master

3.6 Summary

This chapter gives a review on several development methodologies that can be used in the development of CHICALEP. The selected development tools which include programming, multimedia, Chinese language and database tools also have been reviewed.. A few fact finding techniques comprising Internet surfing, market survey, and reference books studying also have been discussed before end of this chapter.

Chapter 4: System Analysis

4.1 Introduction

System Analysis is a systematic investigation of a real or planned system to determine the functions of the system and how they relate to each other and to any other system [bandwidthmarket.com, 2004].

The objectives of system analysis are:

a) To identify the functional and non-functional requirements to be included in the system.

b) To identify the software and hardware requirements for the system execution.

4.2 Requirements Analysis

The requirements analysis defines the requirements for a new system. This analysis can never be skipped but it can integrate with the problem analysis into a single phase. New system will always be evaluated whether or not they fulfilled the system's objective and requirements, and regardless of how impressive or complex the technologies solution might be. The requirements can be divided into functional requirements and non-functional requirements [Whitten, Bentley and Dittman.2000].

4.2.1 Functional Requirements

A functional requirement is a description of activities that a system must provide. Functional requirements are frequently identified in terms of inputs, outputs, and processes that need to satisfy the system improvement objective [Whitten, Bentley and Dittman.2000].

Below are the functional requirements of CHICALEP:

a) *System Login module*

This module is used to ensure that only authorised user can login to CHICALEP and use it.

b) *History and Introduction Module*

These modules give briefings on Chinese characters to the user. It tells the evolvement of the different styles of Chinese character, structures of Chinese character, famous calligraphers with their masterpieces and the use of the four precious writing tools in Chinese calligraphy.

c) *Exercise and assessment module*

i) In CHICALEP, the exercise and assessment is split into three levels namely, Elementary, Intermediate and Advance levels.

ii) This module provides guided exercises to the user on how to write a Chinese character correctly. After the user has written the character on the paper, they must scan their work into the computer. Assessment will be made automatically by the system and marks will be given to the user based on the extent of matching of the user's writing with the sample Chinese character stored in the system database.

d) *Database maintenance module*

This module enables a user to change his login password and add new Chinese characters into the system database.

e) *Help module*

This module provides online help and user manual which aim to aid the user to solve problems encountered when using CHICALEP.

4.2.2 Non-Functional Requirements

A non-functional requirement is a description of other features, characteristic attribute of the system as well as constraints that may limit the boundaries of a satisfactory system. It is an essential definition of the requirements which shows how a system must operate [Whitten, Bentley and Dittman.2000].

The non-functional requirements of CHICALEP are listed below:

a) *User friendly*

   i) The system must be attractive and easy to use. This can be achieved by using "Menu Driven Hierarchical Design" user interface.

   ii) The usage of suitable and meaningful caption and icons will help user to use the system with more confidence.

b) *Correctness*

The information on the literature of Chinese calligraphy must be verified before it is stored into the database. All Chinese characters stored in the database and the order of the handwriting must be entered correctly into the database.

c) *Maintainability and expandability*

The system allows the System Administrator to view and input new Chinese characters into the system database. This enables maintainability and expandability of Chinese characters stored in the system.

4.3 Hardware Requirements

The minimum hardware requirements that must be met to support the system are as follows:

Table 4.1: Minimum Hardware Requirements

Processor speed	Pentium III /AMD K6 processor with 300MHz
Amount of RAM	64 Megabytes
Video device	Any video graphic adapter (VGA) with 8 Megabytes of video memory
CD-ROM	4X CD-ROM
Sound device	Any compatible sound card or chipset
Input device	Mouse, Keyboard
Output device	Speaker,
Display unit	15"monitor
Imaging device	Scanner (MUST HAVE for the assessment)

However, in order to have better view and faster processing speed of the Chinese characters display on the screen, it is recommended to have the following hardware requirements:

Table 4.2: Recommended Hardware Requirements

Processor speed	Pentium III / AMD processor with 800MHz or better
Amount of RAM	128 Megabytes or more
Video device	Any video graphic adapter (VGA) with 32 Megabytes of video memory or more
CD-ROM	52X CD-ROM or better
Sound device	Any compatible sound card or chipset
Input device	Mouse, Keyboard
Output device	Speaker,
Display unit	17"monitor or better
Imaging device	Scanner (MUST HAVE for the assessment)

4.4 Software Requirements

For CHICALEP to run in a personal computer the following software environment is required to support CHICALEP:

a) The operating system (OS) of the user's personal computer **MUST BE** at least one of the following:

Windows® Millennium Edition, Windows® 2000, Windows® XP Home or Professional Edition

b) User's personal computer MUST HAVE **Chinese Star 2001 or Chinese Star XP** to run CHICALEP and to show Chinese character correctly.

c) User's personal computer MUST HAVE **Macromedia® Flash 7.0 ActiveX Control** installed to see the stroke-by-stroke flash animations.

d) **Visual Basic 6.0 Service Pack 5.0 Runtime** must be installed to run CHICALEP.

4.5 Summary

System analysis is one of the most critical phases in software development. In this chapter, the requirements analysis of CHICALEP which includes its functional and non-functional requirements have been discussed. The hardware and software requirements of CHICALEP also have been determined.

Chapter 5: System Design

5.1 Introduction

System design is an important stage in software development. System design means building a system based on the knowledge obtained from the analysis phase. It uses the requirements to design a system that will meet the user's needs [Sellapan, 2000]. It is a process of defining the hardware and software architecture, components, modules, interfaces, and data for a system to satisfy specified requirements. Design phase focuses on both the logical and physical or technical aspects of the system. Using the information obtained from the system analysis phase, the designer proposes a new system that will solve the user's processing problem or meet their current and future needs. The design phase syntheses the various parts into the working system. The design will include database, function or process and other dynamic aspects of the system. The design will also specify how the various functions will be integrated as well as the input / output design and the interface design [Rice, 1999].

5.2 System Design of CHICALEP

This section discusses about the system design of CHICALEP which include:

a) System Architecture

b) Data Flow Diagrams

c) System Interface

5.3 System Architecture

System Architecture means the structure of a system. It is well presented by System Structure Charts, which are used to describe the high-level abbreviation of a specified system. The use of a system structure chart is to describe the interaction among independent modules. Major functions from the initial component part of the structure chart can be broken into detailed sub-components [Whitten, Bentley and Dittman, 2000].

5.3.1 Structure Chart of CHICALEP

The structure chart below shows the main structure of CHICALEP. As shown in Figure 5.1, after a user has login to CHICALEP, he can access the main menu of CHICALEP and explore all the other sub-modules such as Introduction, Exercise and Assessment, Maintenance, Assessment Result, etc.

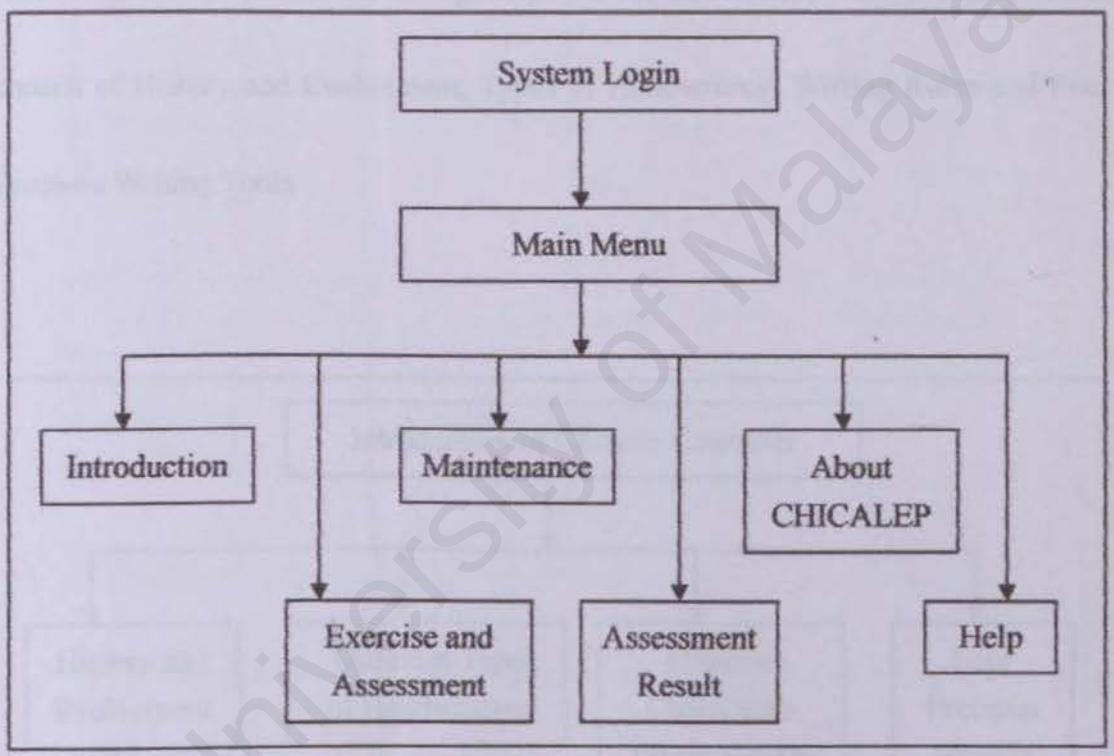


Figure 5.1: Structure Chart of CHICALEP System

5.3.2 Introduction Sub-module

When the users explore the Introduction sub-module, if they want to know more about the history and evolvement of Chinese characters, they can select the "History and Evolvement" tab. Different types of writing style exist as Chinese characters evolved, thus contributing to the formation of different writing rules and writing tools. Figure 5.2 shows the components of the Introduction sub-module, which consist of History and Evolvement, Types of Handwriting, Writing Rules and Four Precious Writing Tools.

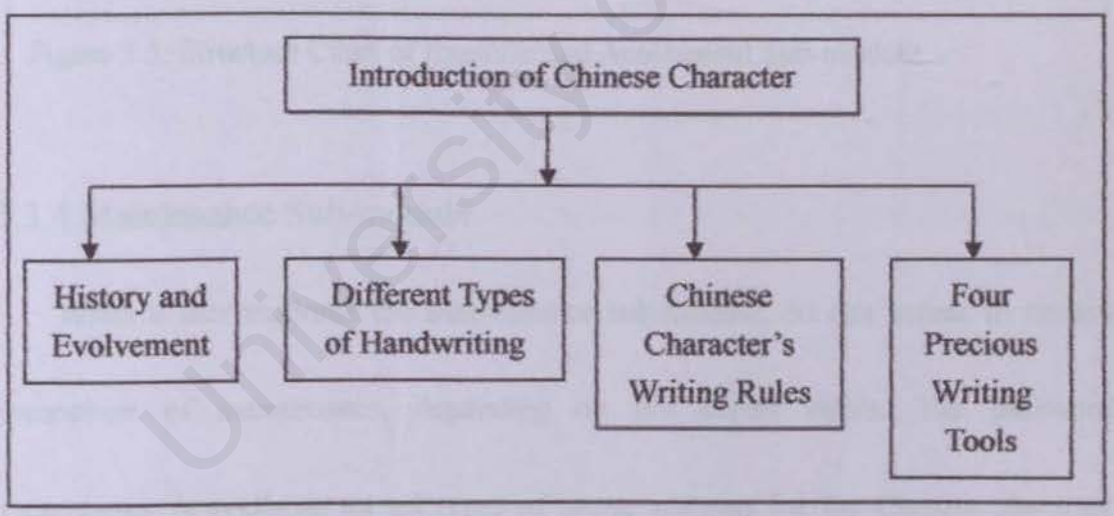


Figure 5.2: Structure Chart of Introduction Sub-module

5.3.3 Exercise and Assessment Sub-module

At the main menu, a user can access to three different levels of exercise namely, Elementary, Intermediate and Advanced levels. At each level, user can make assessment at anytime.

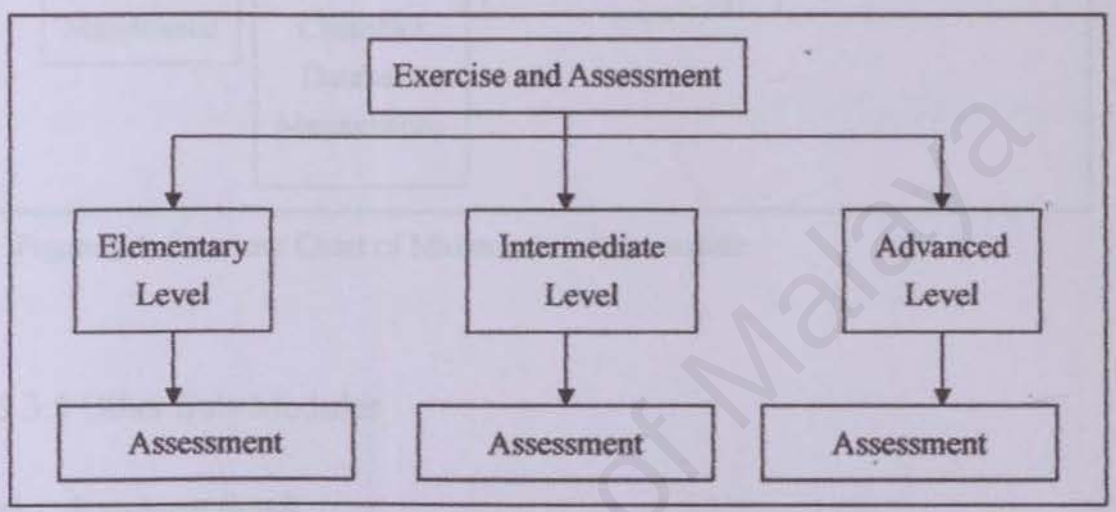


Figure 5.3: Structure Chart of Exercise and Assessment Sub-module

5.3.4 Maintenance Sub-module

When a user explores the Maintenance sub-module, he can access to certain component of maintenance, depending on his access rights. The password maintenance is available for all types of users, whereas for the Chinese character database, delete user and restore database maintenance, they are only available to user with administrator's rights.

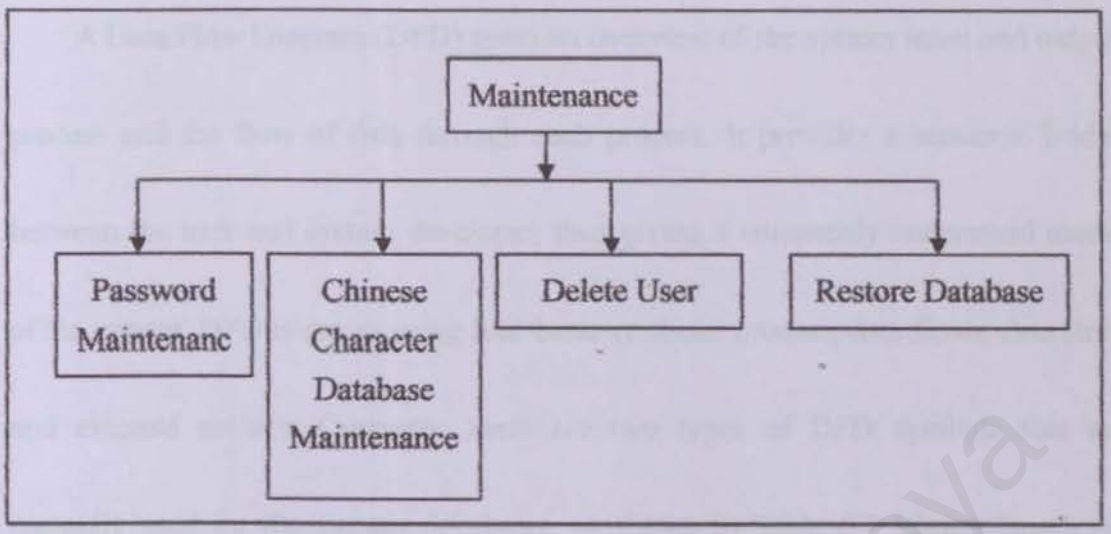


Figure 5.4: Structure Chart of Maintenance Sub-module

5.3.5 Other Sub-Modules

a) Assessment Result

This sub-module shows the current assessment result to the user. It is a table which consists of the total number of characters learned, the average percentage, the highest percentage and the grade for each level.

b) About CHICALEP

This sub-module provides the information about CHICALEP and its copyrights.

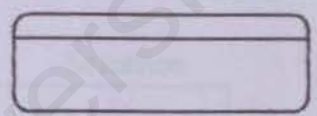
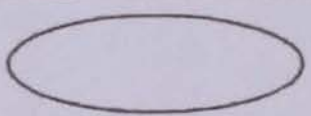
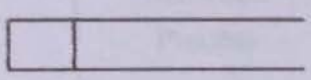
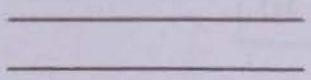
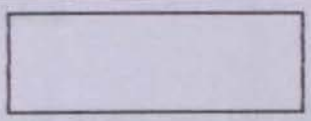
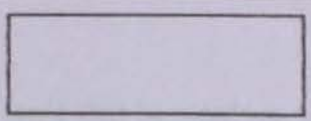
c) Help and manual

This sub-module provides online help to the user when the user encounters problem while using CHICALEP.

5.4 Data Flow Diagram

A Data Flow Diagram (DFD) gives an overview of the system input and output, process and the flow of data through each process. It provides a semantic bridge between the user and system developer, thus giving a commonly understand model of the system. DFD is drawn using four basic symbols: process, data flows, data store and external entities. Currently, there are two types of DFD symbols that are normally used by the system developer, as shown in Table 5.1 [SmartDraw.com, 2004]:

Table 5.1: DFD Notation of Gane and Sarson and Yourdon and Coad

DFD Basic Symbols	**Gane and Sarson Notation**	**Yourdon and Coad Notation**
Process		
Data Flow		
Data Store		
External Entity		

5.4.1 DFD for System Login

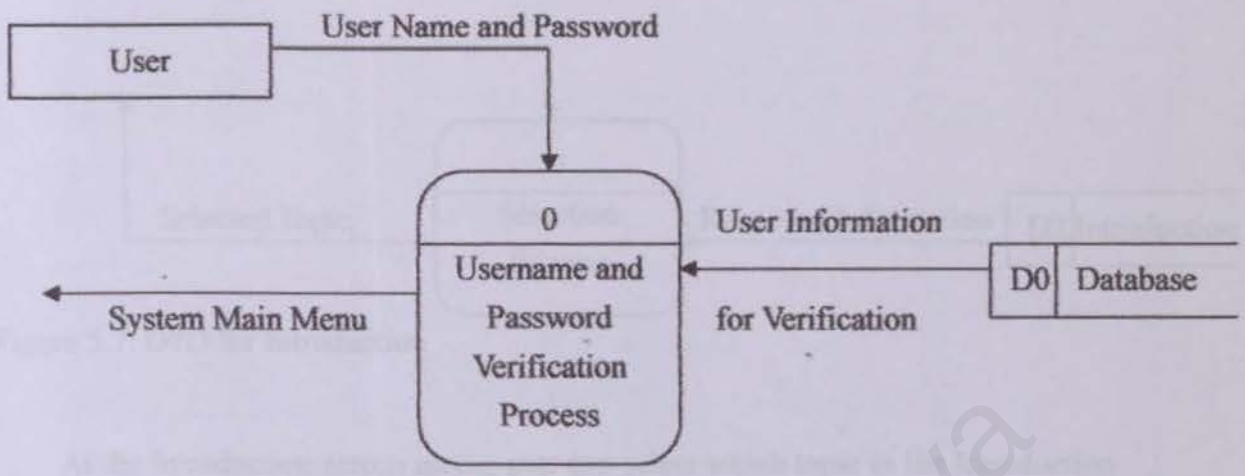


Figure 5.5: DFD for System Login

At the system login screen, user must input his username and password to access to the system main menu.

5.4.2 DFD for Main Menu

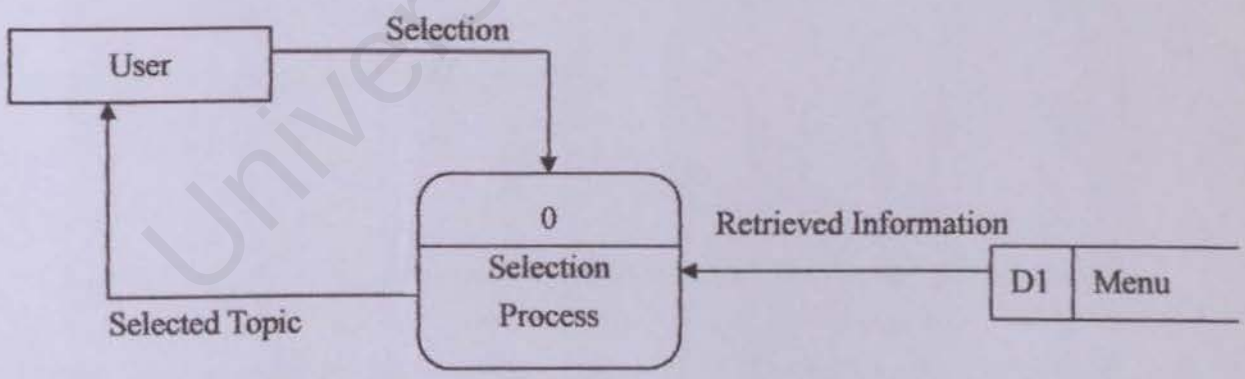


Figure 5.6: DFD for Main Menu

At the system main menu screen, user can select the topic that he wants to view. After the user has made his selection, the system will display the topic to the user based on the user's choice.

5.4.3 DFD for Introduction

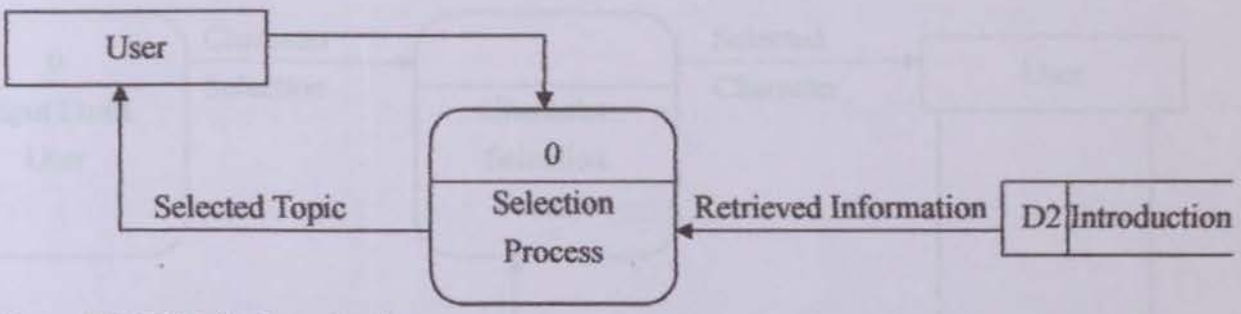


Figure 5.7: DFD for Introduction

At the Introduction screen menu, user can select which topic in the Introduction Menu to be viewed. Then, the system will retrieve the related topic from the database and display to the user.

5.4.4 DFD for Exercise and Assessment

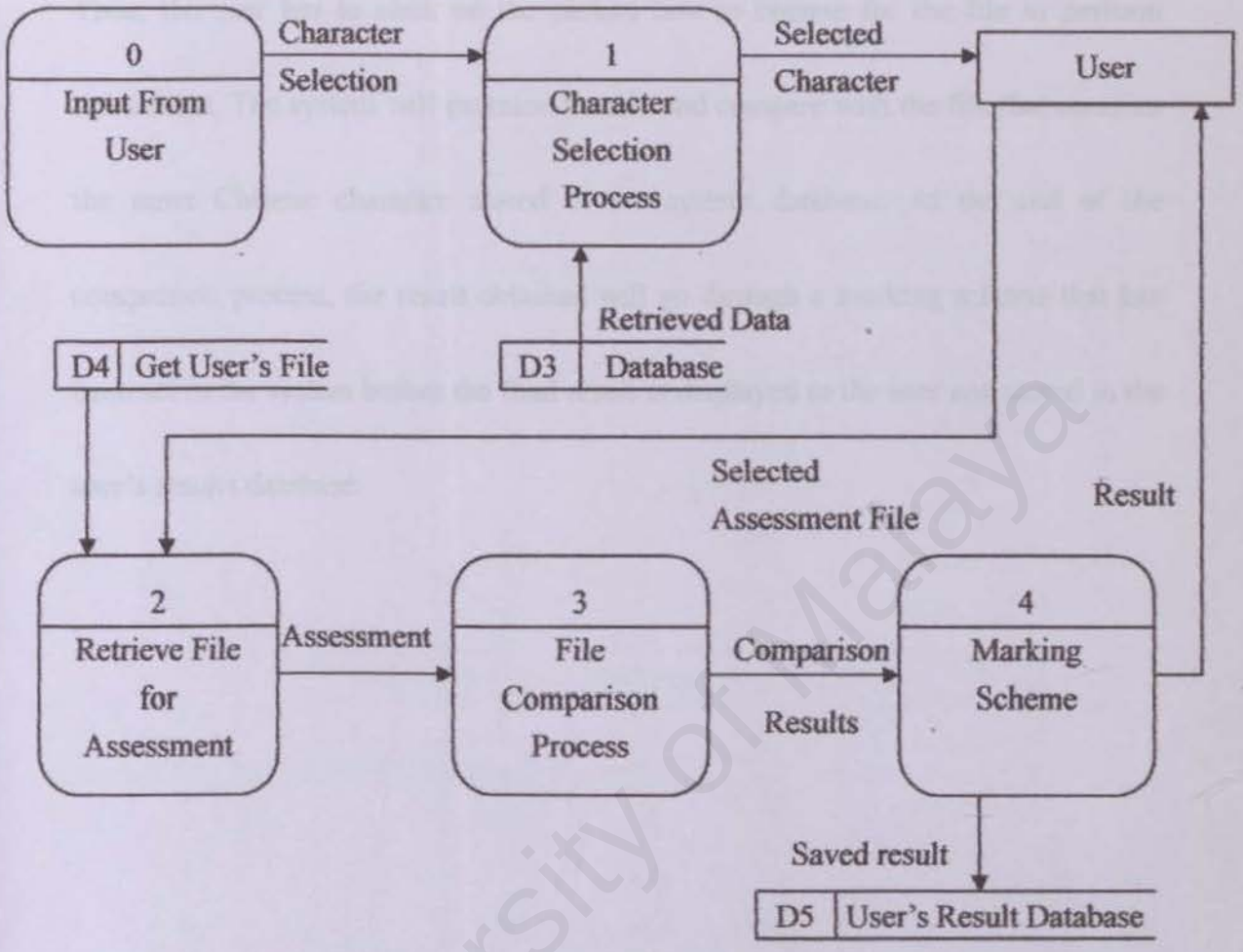


Figure 5.8 : DFD for Exercise and Assessment

At any level of the Exercise and Assessment screen menu, user can select the Chinese character to be viewed. After the user has input his selection, the system will search the database to get the specific Chinese character. The system will display the character and a flash movie to the user on how to write the character in its proper strokes and correct sequence. The user can follow the flash movie and practise writing on a piece of white paper or Chinese calligraphy writing paper. After that, the

user can use a scanner to scan his work into the computer and save as an image file. Then, the user has to click on the picture box to browse for the file to perform assessment. The system will examine the file and compare with the file that contains the same Chinese character stored in the system database. At the end of the comparison process, the result obtained will go through a marking scheme that has been set in the system before the final result is displayed to the user and stored in the user's results database.

5.4.5 DFD for Maintenance (Change Password)

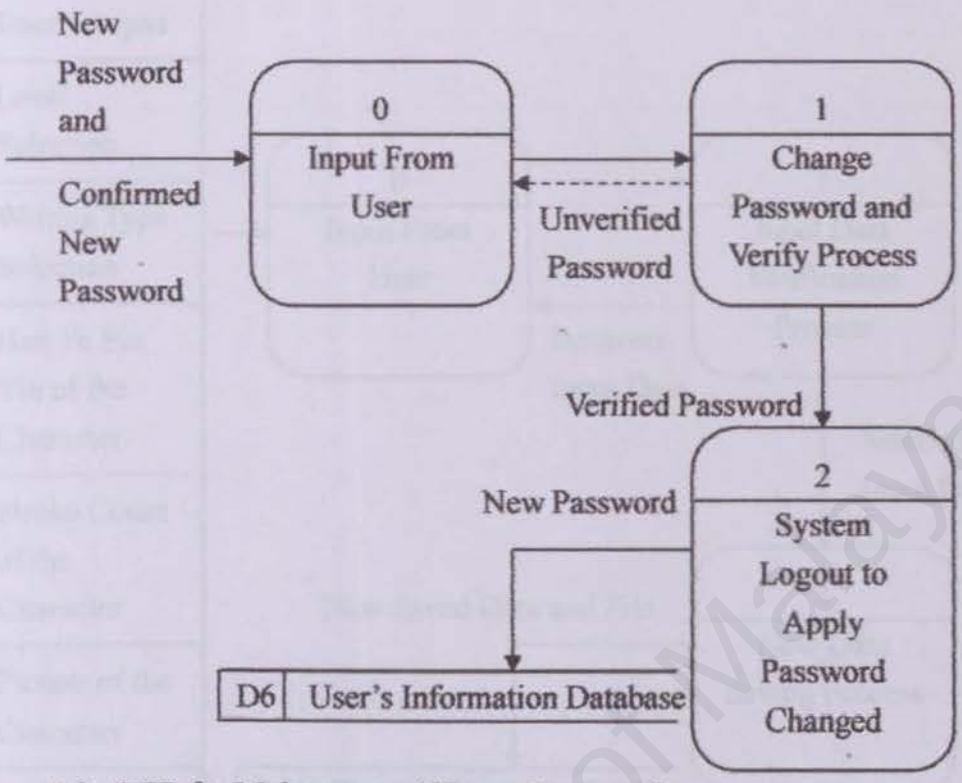


Figure 5.9 : DFD for Maintenance (Change Password)

At the Maintemance menu, the "Change Password" option is available to all users. User have to input the new password, and confirm it in the next field. Then, the user can apply the new password entered by clicking on the "Apply" button. The system will verify and update the user password. If the password is not verified, then the user have to re-enter the new password. After that, the user is required to log out from the system to activate the changed password. Then, the user can log into CHICALEP again using the new password.

5.4.6 DFD For Maintenance (Add New Chinese Character)

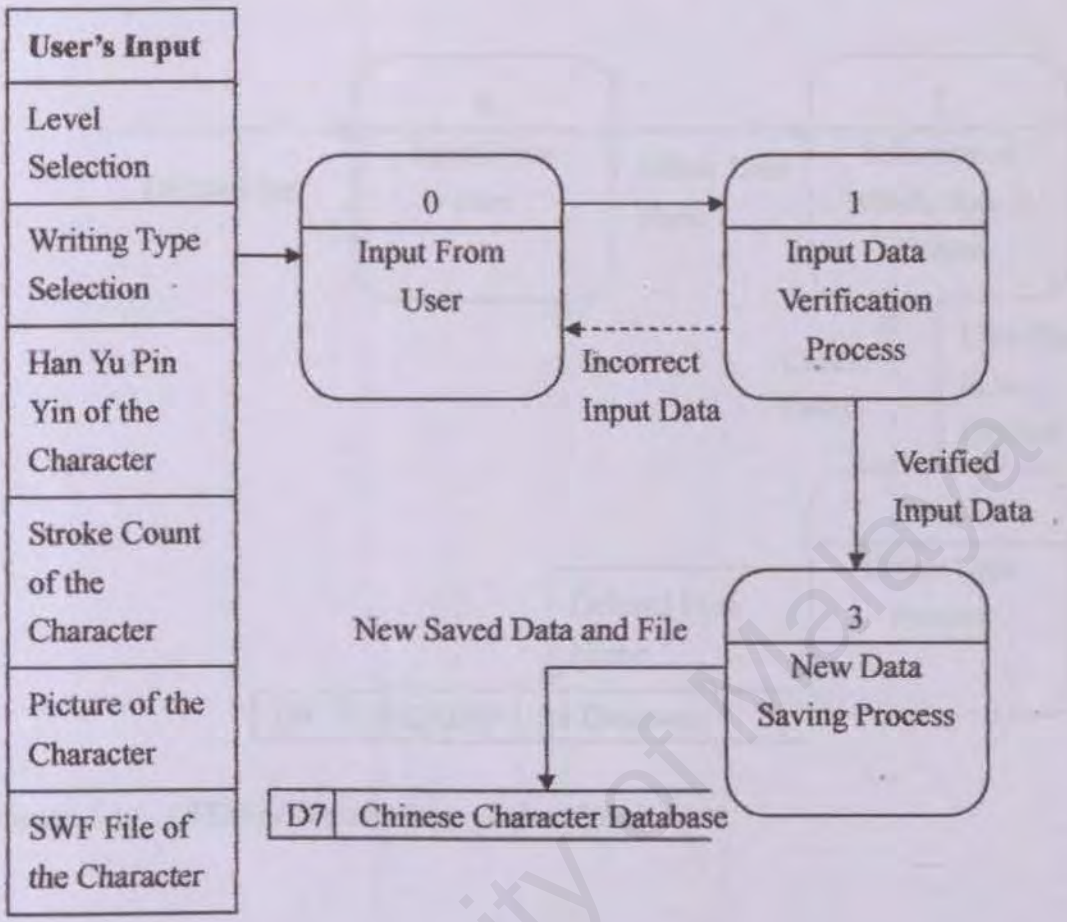


Figure 5.10 : DFD for Maintenance (Add New Character)

This option is only available to the system administrator. To add a new chinese character into CHICALEP database, the user have to input a few items which include the Level, Writing Style, Han Yu Pin Yin, Stroke Count, Picture and SWF File of the character. After the user has clicked on the "Add Into Database" button, the system will verify all the input data. If invalid data detected, the user have to input the data again, otherwise, all the verified data will be saved into the system database.

5.4.7 DFD For Maintenance (Delete User)

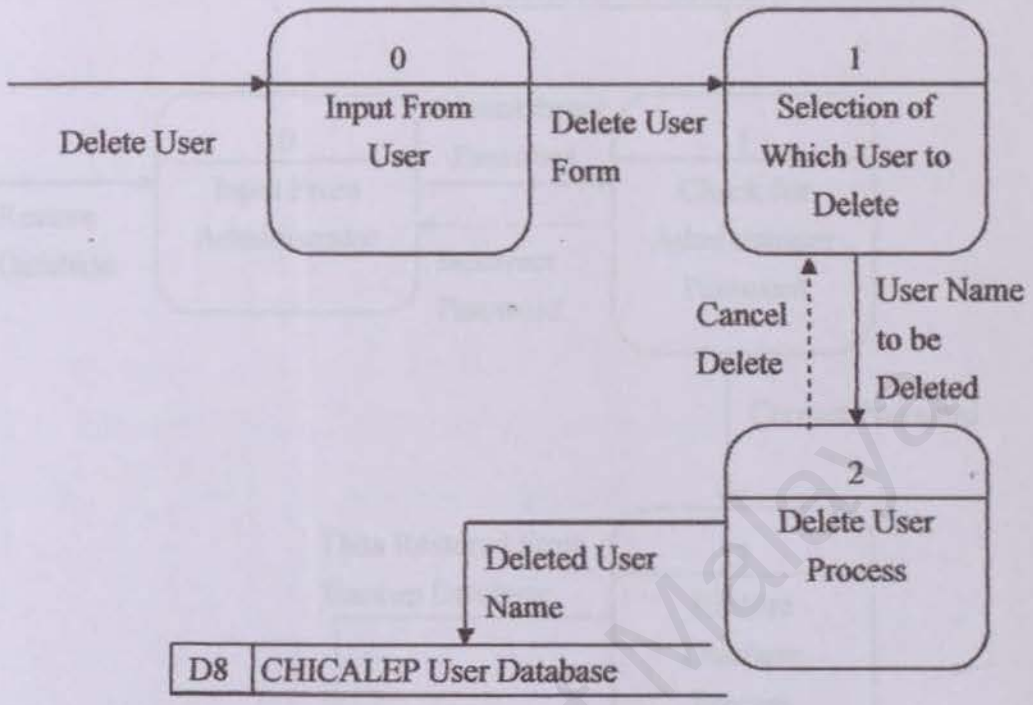


Figure 5.11 : DFD For Maintenance (Delete User)

This option is only available to the system administrator. At the system main menu, when the user clicks on the "Delete User" button, a "Delete User Form" will appear. User can select the user name to delete from the list and delete it by clicking on the "Delete" button. If the user confirms the delete, then the system will delete the selected user from the system database permanently. At this moment, the assessment result of the deleted user will also be deleted.

5.4.8 DFD For Maintenance (Restore Database)

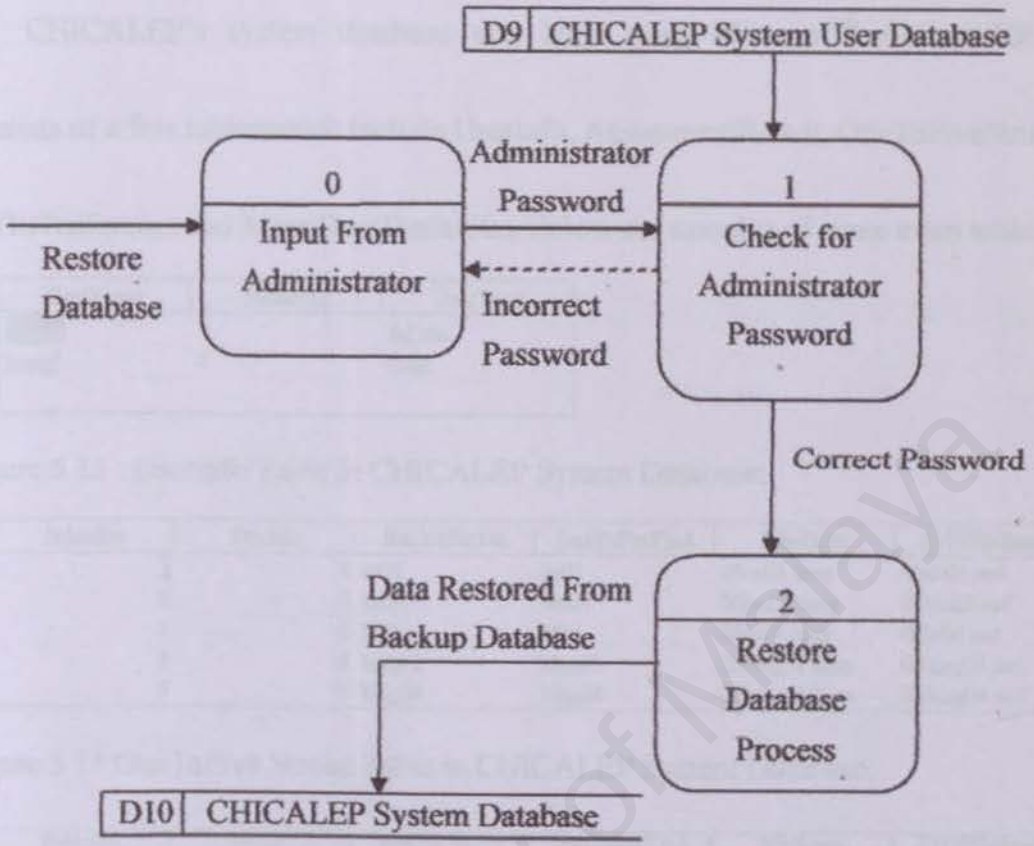


Figure 5.12 : DFD For Maintenance (Restore Database)

This option is only available to the system administrator. At the system menu, when the user clicks on "Restore Database" button, a new window will pop up. User have to input the Admin password, then, clicks on the "Restore Database" button shown on the new window. If password is correct, then, the "Restore Database" process will be performed. Database are restored by copying the data from the backup database. The user's data which include the user name, password, and assessment result are not re-initialized, except for all chinese characters data that need to be re-initialized.

5.5 CHICALEP's Database Design

CHICALEP's system database was built using Microsoft® Access XP. It consists of a few tableswhich include Userinfo, AssessmentResult, OneToFiveStroke, SixToTenStroke, and MoreThanTenStroke. Below are samples of some main table:

	UserName	Password	UserType
▶	[redacted]	*	Admin
	lowpf	*	User
*			

Figure 5.13 : Userinfo Table in CHICALEP System Database.

	IndexNo	Strokes	HanYuPinYin	HanYuPinYinA	FileName	SWFFileName
▶	1	6	an01	an01	06an01.bmp	06an01.swf
	2	6	bai03	bai03	06bai03.bmp	06bai03.swf
	3	6	bi04	bi04	06bi04.bmp	06bi04.swf
	4	6	bing01	bing01	06bing01.bmp	06bing01.swf
	5	6	bing04	bing04	06bing04.bmp	06bing04.swf

Figure 5.14 OneToFive Stroke Table in CHICALEP System Database.

	IndexNo	Strokes	HanYuPinYin	HanYuPinYinA	FileName	SWFFileName
▶	1	6	an01	an01	06an01.bmp	06an01.swf
	2	6	bai03	bai03	06bai03.bmp	06bai03.swf
	3	6	bi04	bi04	06bi04.bmp	06bi04.swf
	4	6	bing01	bing01	06bing01.bmp	06bing01.swf

Figure 5.15 SixToTenStroke Table in CHICALEP System Database

	IndexNo	Strokes	HanYuPinYin	HanYuPinYinA	FileName	SWFFileName
▶	1	11	an01	an01	11an01.bmp	11an01.swf
	2	11	ben04	ben04	11ben04.bmp	11ben04.swf
	3	11	biao01	biao01	11biao01.bmp	11biao01.swf
	4	11	can03	can03	11can03.bmp	11can03.swf
	5	11	cao02	cao02	11cao02.bmp	11cao02.swf

Figure 5.16 MoreThanTenStroke table in CHICALEP System Database

	UserName	Level	Style	HanYuPinYin	FileName	Result
	lowpf	Elementary	Li	qian01	03qian01.bmp	80.54
	lowpf	Elementary	Li	qian01	03qian01.bmp	80.54
	lowpf	Elementary	Li	ma03	03ma03.bmp	97.09
	lowpf	Intermediate	Kai	an01	06an01.bmp	100
	lowpf	Elementary	Li	ma03	03ma03.bmp	97.09

Figure 5.17 AssessmentResult table in CHICALEP System Database.

5.6 CHICALEP's User Interface Design

User interface of CHICALEP was built purely using Microsoft® Visual Basic 6.0 (VB6). Thus, its user interface has adopted some good features from VB6. It has a very nice and friendly user interface as shown below:

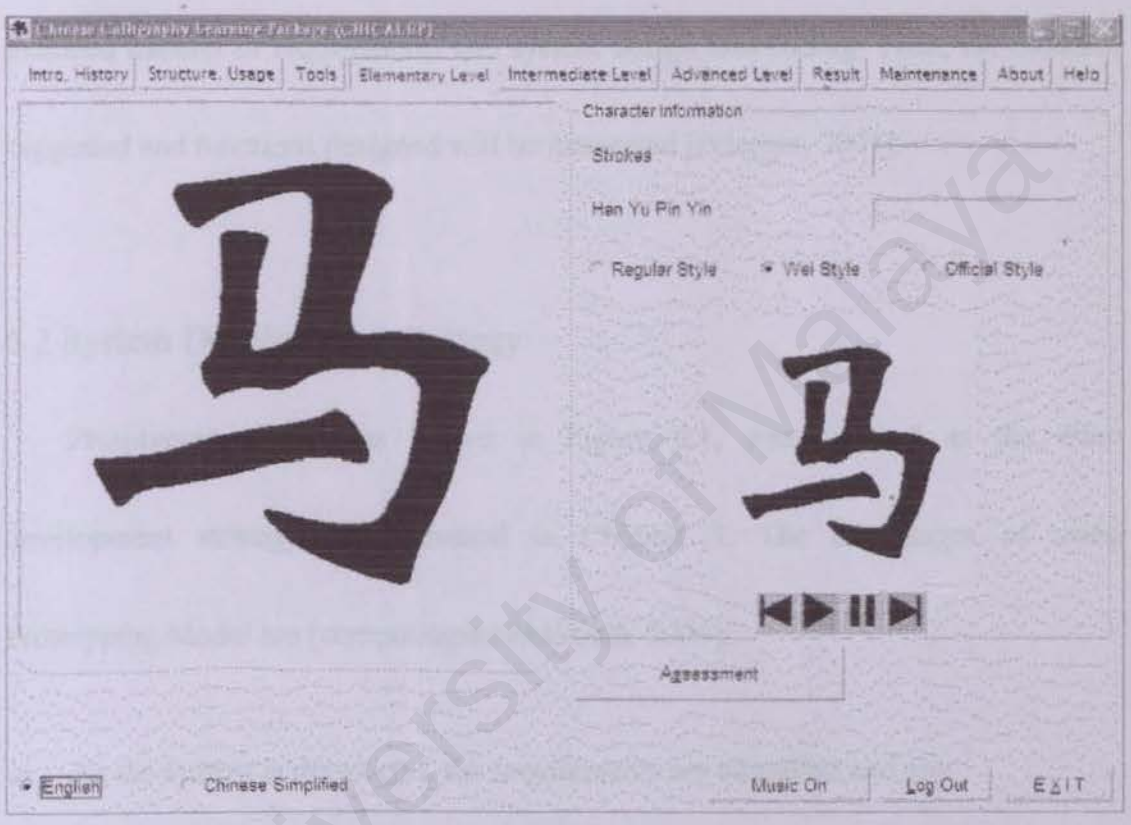


Figure 5.18 : User Interface Design of CHICALEP

5.7 Summary

The CHICALEP system structure has been designed and presented by a structure charts. The data flow of CHICALEP are illustrated in the DFD diagrams. Besides, the database and interface design of CHICALEP are also explained briefly.

Chapter 6 : System Implementation & Testing

6.1 Introduction

System Implementation is a process to develop and deliver a system as a final product. It consists of the processes to develop and testing of the system, which included transfer of requirements and system design into coding. Then, the modules suggested and functions designed will be integrated [Pfleeger, 2001].

6.2 System Development Strategy

Prototyping Model, as shown in Figure 6.1, was selected as the main development strategy, as discussed in Chapter 3. The advantages of using Prototyping Model are [computingstudents.com. 2004]:

a) As the system is developed, the requirements are classified and any misunderstandings between the user and the developer are effectively removed.

b) Missing services can be detected.

c) The system can be made user-friendly by removing any complications identified by the user.

d) Developers may come across inconsistent requirements as the prototype is built. But it can be identified and resolved at the early development phase.

e) A raw version is at hand to demonstrate the feasibility and the usefulness of the application to the user.

f) It serves as a basis for writing specifications for quality systems.

g) By developing a prototype, requirement and design risks can be reduced.

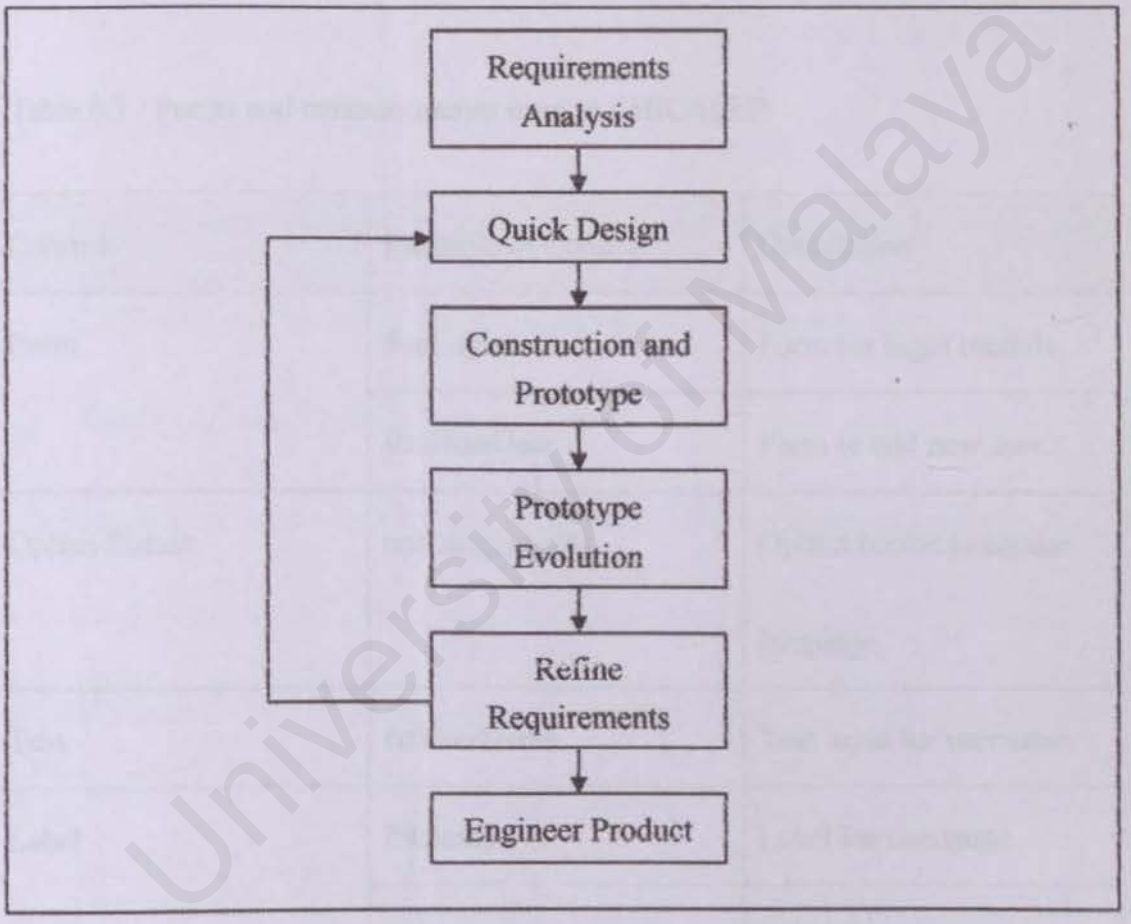


Figure 6.1 : Prototyping Model

6.3 Naming Convention

Naming convention is a very important aspect in the coding process of CHICALEP. It is an abbreviation of the control name or the object name. This step is important to ensure uniformity of the control and object names. Below are the names of some of the forms and controls used in CHICALEP:

Table 6.1 : Forms and controls names used in CHICALEP

Control	Example of Control	Description
Form	frmLogin	Form for login module.
	frmNewUser	Form to add new user.
Option Button	optLanguage(0)	Option button to choose language.
Text	txtUserName	Text input for username.
Label	lblName	Label for username.
	lblPassword	Label for password.
Command Button	cmdDeleteUser	Command button to delete user.
	cmdRestoreDatabase	Command button to restore database.

6.4 Coding Style

Coding is the process of writing the program instructions that implement the program design. There are some rules to obey when coding:

a) Indentation of codes

Suitable indentation of the coding style will increase the readability of the program code, especially when debugging of program code at testing stage.

b) Documentation in program code

Documentations such as comments are inserted along with the program code. This will helps the developer to understand what is doing by the coding lines.

c) Spacing between codes

Spacing is needed in the program coding to help differentiate some related block of coding from the other.

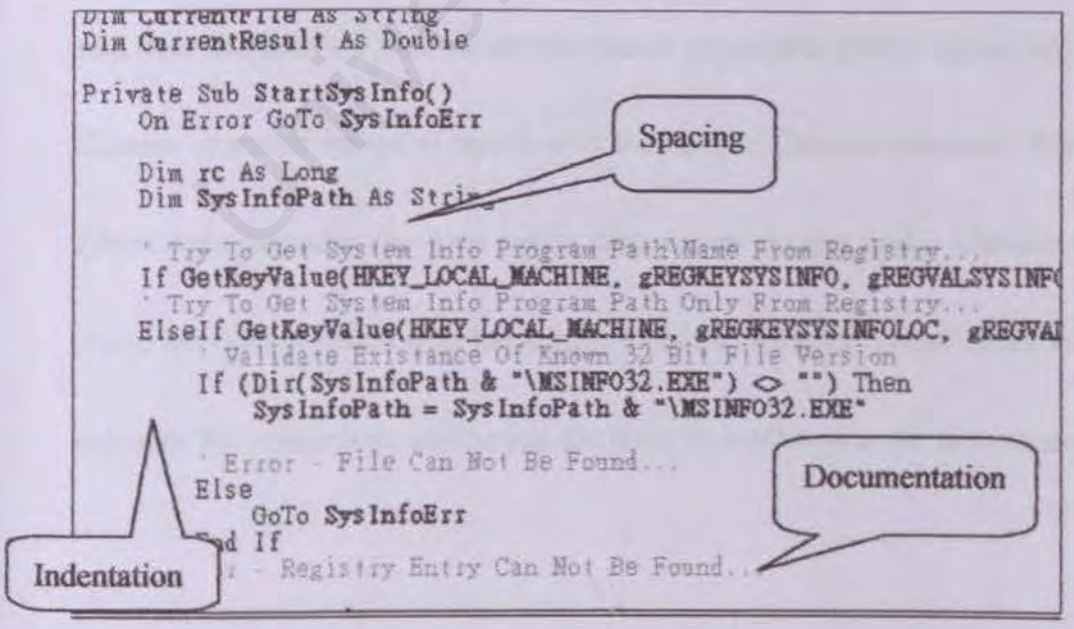


Figure 6.2 : Sample Coding of CHICALEP

6.5 Comparison Algorithm

The most interesting part in this project is how the program calculates how extend the user's writing matches with the sample of the Chinese character stored in the database.

The comparison algorithm uses a **pixel-to-pixel comparison**. While the algorithm compares the pixels on the two image files, it will also calculate the total pixels on the sample Chinese character and the total pixels that did not match with the user's character image. Then, the algorithm calculates the difference as the assessment result, that is, the total matched pixels is the final assessment result.

In Figure 6.3, there are three variable used to store the important value namely, blackCount, which used to store the total pixels of the sample Chinese charater, redCount and greenCount, which are used to store the total unmatched pixels. The redCount indicates the total pixels that should appear but did not appear on the user's Chinese character image to match with the sample Chinese character. Whereas the greenCount indicates the total pixels that appear on the user's Chinese character image but did not match with the sample Chinese character. These values are used to calculate the assessment result using the formula explained in the next section.

```
For x = 0 To P2.ScaleWidth
    For y = 0 To P2.ScaleHeight
        If GetPixel(P2.hdc, x, y) = vbBlack Then
            blackCount = blackCount + 1
        End If
        If GetPixel(P1.hdc, x, y) <> GetPixel(P2.hdc, x, y) Then
            If GetPixel(P1.hdc, x, y) = vbBlack And GetPixel(P2.hdc, x, y) = vbWhite Then
                P2.PSet (x, y), vbRed
                redCount = redCount + 1
            ElseIf GetPixel(P1.hdc, x, y) = vbWhite And GetPixel(P2.hdc, x, y) = vbBlack Then
                P2.PSet (x, y), vbGreen
                greenCount = greenCount + 1
            End If
        End If
    Next
Next

'Catch and handle "division by 0" before occur
If blackCount = 0 Then
    GoTo ErrorExit
End If

CurrentResult = 100 - Format((redCount + greenCount) / blackCount * 100, "#.00")
```

Total pixels of the sample Chinese character.

Total unmatched pixels that did not match with the sample Chinese character.

Calculate the difference as the final result.

Figure 6.3 : The Pixel-to-Pixel Comparison

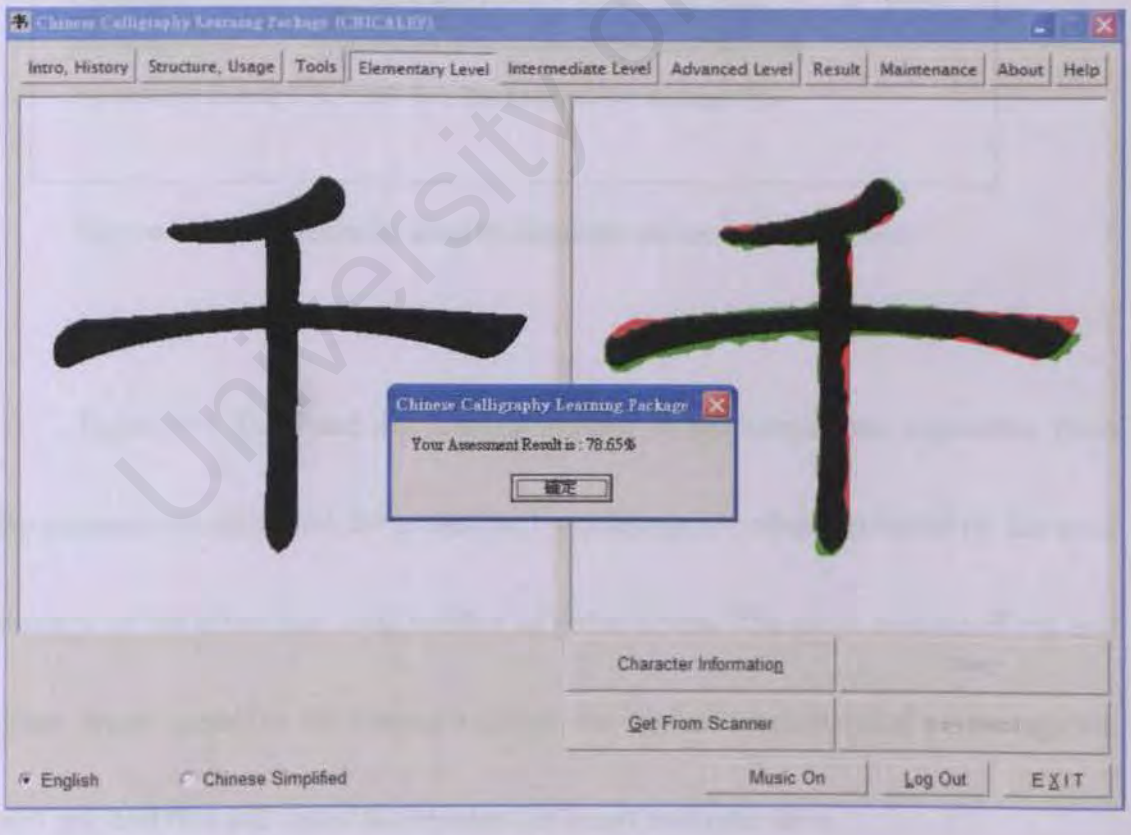


Figure 6.4 : Sample Comparison Result

6.5.1 The Formula To Calculate The Assessment Result

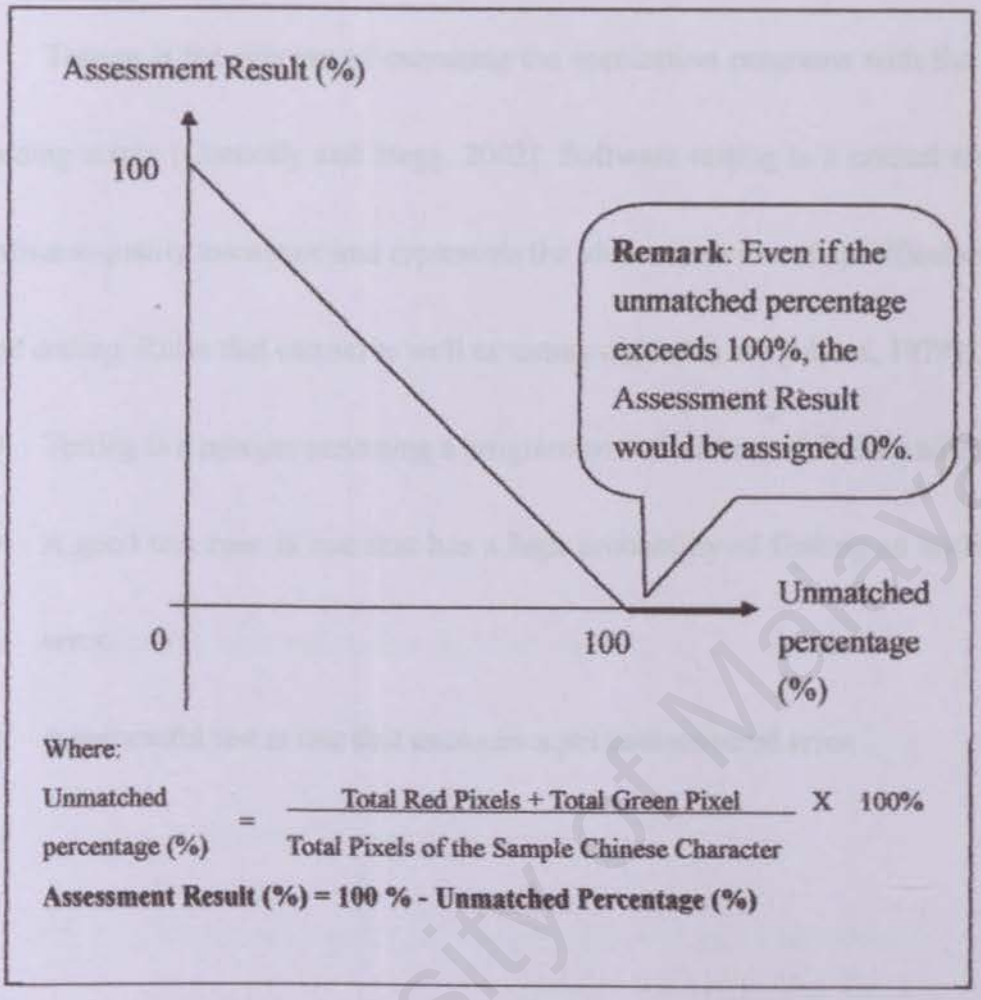


Figure 6.5 : The formula used to calculate the assessment result.

Figure 6.5 illustrated the formula applied in the comparison algorithm. Both the assessment result and the unmatched percentage are obtained based on the total number of red pixels and total number of green pixels. The more number of red and green pixels appear in the character image, the higher the unmatched percentage we will get, and this will lower the assessment result and vice versa.

6.6 Testing

Testing is the process of executing the application programs with the intent of finding errors [Connolly and Begg, 2002]. Software testing is a critical element of software quality assurance and represents the ultimate review of specification, design and coding. Rules that can serve well as testing objective are [Myers, 1979]:

a) Testing is a process executing a program with the intent of finding an error.

b) A good test case is one that has a high probability of finding an undiscovered error.

c) A successful test is one that uncovers a yet undiscovered error.

6.6.1 Test Case Design

Any system can be tested using one of the two test case design. They are White Box Testing and Black Box Testing as describe as below [Roger S. Pressman, 1997]:

a) White Box Testing (WBT)

WBT is carried out at the early stage of the testing process. It is performed to ensure that internal operation of a system according to specification and all internal components have been adequately exercised. Using this method, a software engineer can derive test case that:

i) Guarantee that all independent paths within a module have been exercised at least once;

ii) Exercise all logical decisions on their true and false sides;

iii) Execute all loops at their boundaries and within their operational bounds;

iv) Exercise internal data structure to assure their validity.

b) Black Box Testing (BBT)

WBT is concerned with internal working of a product. BBT is conducted to demonstrate that each function is fully operational, at the same time searching for errors in each function. This testing approach enables a software engineer to derive sets of input conditions that will fully exercise all functional

requirements for a program. It is a complementary approach that is likely to uncover a different class of error.

BBT attempts to find errors in the following categories [Wikis.com, 2000]:

i) Incorrect or missing function.

ii) Interface error.

iii) Errors in data structure or external database access.

iv) Performance error.

v) Initialisation and termination errors.

6.6.2 Testing of CHICALEP

Testing was conducted throughout the development of CHICALEP system. It consists of Unit Testing, Integration Testing and System Testing.

a) Unit Testing

Unit testing is a WBT technique. Unit testing is accomplished by developing test data that will force the computer to execute every statement in the program. In addition, each program is tested with abnormal data to determine how it will handle problems with bad data [Stair, 1996]. Unit testing was conducted during the development of CHICALEP. For example, an alphabet is used as input for the number of stroke while finding Chinese character. This will cause the

program to generate an error message because that field requires a number as input.

b) *Integration Testing*

Integration testing interconnects sets of previously tested modules to ensure that the sets behave as well as they did as independently tested modules [Davis, 1993]. Integration testing approach was applied during the development phase of CHICALEP. Components of CHICALEP were tested in small arguments, where errors were easier to isolate and correct. Errors were corrected before proceeding to the next integration.

c) *System Testing*

System testing is designed to reveal bugs that cannot be attributed to individual component, or to the interaction among components. System testing studies all the common issues and behaviours that can only be exposed by testing the entire integrated system or a major part of it. System testing includes testing of performance, stress, security, configuration sensitivity, usability, data integrity, start-up and recovery. System testing verified that CHICALEP functions properly and the project objective have been achieved as defined in the requirements analysis.

6.7 Summary

This chapter explains the development strategies used in implementing the CHICALEP system. The development strategies such as the naming conventions, coding styles, comparison algorithm applied, and various testing technique used are discussed in detailed.

Chapter 7: System Evaluation and Conclusion

This chapter discusses the problems encountered and the solutions during the system development of CHICALEP; strengths and limitations as well as the future enhancements of CHICALEP. This chapter concludes by discussing the applications and usefulness of CHICALEP.

7.1 Problems Encountered

Several problems were encountered during the development of CHICALEP. These include:

a) During analysis phase

i) *Choosing programming tools and database tools.*

Choosing an appropriate programming tool and database tool is a critical process as it would eventually affect the strengths and weaknesses of CHICALEP.

ii) *Determine the scope and contents of system to be built.*

It is impossible to build a complete computer-aided learning package for Chinese calligraphy that contains all Chinese characters with three different writing styles within seven months (twenty-eight weeks). Hence, the contents of CHICALEP only consist of three hundred

Chinese characters with three different writing styles namely, regular, official, and "Wei" styles (i.e. altogether nine hundred Chinese characters).

b) During system design phase

i) *Time constraint and lack of knowledge and experience.*

Due to time constraint and lack of knowledge and practical experience in designing a system, it was not possible to produce the best design for CHICALEP within fourteen weeks in 1st semester. This problem was overcome by referring to the approaches used by previous students' project reports and obtained information from Internet discussion forums.

c) During implementation phase

i) *No prior experience in using multimedia tools.*

Due to no prior experience in using multimedia tools such as Macromedia Flash MX, a lot of time spent to learn and understand the various form of animations. This problem was solved by downloading examples and tutorials from the Internet, which had helped me to master the tools faster.

7.2 System Strengths

CHICALEP was built using Microsoft® Visual Basic 6.0 and Macromedia Flash MX, and integrated with Web elements. The applications of these development software have helped to achieve:

a) *User-friendly interface.*

CHICALEP provides a very user-friendly interface and consistent environment to the user. All captions of buttons and labels are clear and easy to understand. User will feel very convenient when using CHICALEP as he can refer to the online help provided by the system when he encounters problem.

b) *Enable various writing styles of Chinese characters with stroke-by-stroke animations and character information.*

CHICALEP provides three different writing styles with three hundred characters each, plus stroke-by-stroke animations for each character, showing the user how to write a Chinese character correctly. Besides, the number of strokes and the character's "Han Yu Pin Yin" are also displayed to the user as additional information about the character to enhance the user's understanding of the Chinese character that he is learning.

c) *Enhanced with Web features.*

All the information explanation pages of CHICALEP system were coded in Hyper Text Markup Language (HTML) codes. Java scripts were applied in those pages to enable animation such as auto-scrolling of page.

d) *Bilingual system*

CHICALEP is a bilingual learning package which can switch between English and Simplified Chinese character. This is very convenient to users who know either English or Chinese when learning Chinese characters through CHICALEP.

7.3 System Limitations

Due to time constraint, it is impossible to develop a very comprehensive Chinese calligraphy learning package in seven months. Below are some of the limitations and weakness of CHICALEP:

a) *Limited number of Chinese characters*

CHICALEP stores only three hundred different Chinese characters in three different writing styles. This is not sufficient for a user who wants to master the Chinese language. To master this language, a user is required to master about one thousand Chinese characters besides the Chinese language grammar in order to use it proficiently in daily life.

b) *Lacking in sound feature*

It would be much helpful to the users if CHICALEP can provide sound when showing the animation of a character stroke-by-stroke.

c) *Chinese language software dependency*

Chinese Star 2.97, Chinese Star 3.0, or Chinese Star XP is a pre-requisite software needed to run CHICALEP under the Windows operating system such as Windows ME, Windows 2000, or Windows XP. Without the Chinese language software, CHICALEP will not function according by specifically for the display of Chinese characters.

d) Operating system limitation

CHICALEP only works well under any of the Windows operating system but not other operating systems such as the Macintosh or Linux.

7.4 Future Enhancements

The future enhancements of CHICALEP are based on the limitations discussed above. These include:

a) CHICALEP can be enhanced to support more languages such as Arabic, Malay, French, or Spanish. These would certainly help those foreigners who are not Chinese speaking to learn Chinese characters in their own specific native language. In order to be a multi-lingual system, obviously it is necessary to install all the foreign language software into CHICALEP. A thorough testing process also needs to be conducted to ensure that CHICALEP can run in multi-lingual environment.

b) More Chinese characters and animations can be added and incorporated into CHICALEP to enlarge and enrich its Chinese character database.

c) The learning process can be made more interesting and attractive if sound is incorporated into CHICALEP to explain the writing of Chinese character stroke-by-stroke in the correct order.

d) Calculate and display the assessment result based on individual Chinese character instead of calculating the average of all the Chinese character written. This will give a more precise assessment result of the specific Chinese character that the user can write better.

7.5 Conclusion

CHICALEP has achieved its goal as a Chinese calligraphy learning package, fulfilled all functional and non-functional requirements, as defined in the requirements analysis. It has a step-by-step feature that enables user to learn Chinese calligraphy with a very clear view on each stroke. With CHICALEP, user also can learn more about the history of Chinese character, different types of writing style, and the four precious writing tools of Chinese calligraphy.

CHICALEP also successfully implemented, as expected, as a bilingual system that allow a user to view its contents in either English or Simplified Chinese characters. User can change the language mode at anytime without affecting its performance. This feature can fulfil the needs of those users, who do not know Chinese, but wish to learn Chinese calligraphy in English.

This package has a very nice user-friendly interface with simple labels which are easy to understand. Thus, this will give more attraction and motivation to the users to learn Chinese calligraphy using CHICALEP.

The development of CHICALEP is a very challenging task. Great efforts of research and time have been spent to make this project a success. Indeed, priceless knowledge has been gained while developing CHICALEP. The exposition to the process and software development environment, have given me an opportunity to learn, use, master, and apply the development tools namely, Macromedia® Flash and Microsoft® Visual Basic 6.0 to develop CHICALEP.

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Appendix A:

CHICALEP User Manual

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System Requirements

Table 1 : System Requirements

	Minimum Specifications	Recommended Specifications
Operating System	English Version : Windows ME, Windows 2000, Windows XP * All OS above **Must Have Chinese Star Version 2.97, 3.0 or XP**, switch to **Chinese Simplified (GB2312)** to view the content of the software properly.	English Version : Windows 2000, Windows XP * All OS above **Must Have Chinese Star Version 2.97, 3.0 or XP**, switch to **Chinese Simplified (GB2312)** to view the content of the software properly.
Processor Speed	Pentium-III or AMD Athlon / Duron with 300MHz or better	Pentium-4 Processor with 1.4GHz or better
RAM (MB)	64MB or more	256MB or more
Display Card	8 MB or more Direct3D Compatible Graphics Card	32MB or more AGP Graphic Card
CD-ROM / DVD-ROM	40X or better / 8X or better	52X or better / 16X or better
Sound	Sound Blaster compatible	AC'97 Sound Blaster Compatible
Hard Disk Space	250MB + 100MB for windows swap file	250MB + 100MB for windows swap file
Scanner	**MUST HAVE** in Any Model (Use For Assessment)	**MUST HAVE** in Any Model (Use For Assessment)

Remark: To scan user's writing directly from scanner into the CHICALEP system, user must have a WIA compatible scanner and the operating system installed must be Windows XP Home or Windows XP Pro. Any operating system other than these two, user have to scan the writing manually. Then, browse in CHICALEP to make assessment.

Installation

User must install CHICALEP software from the CD-ROM before running the software. To install the CHICALEP software, insert the CHICALEP CD into the CD-ROM, double-click on the **My Computer** icon, double-click on the **CD-ROM** icon, then double click on the **Installer** folder icon, and lastly double-click on the **"Setup.exe"** file to start the installation process.

User will be prompted to select the path and directory where the user wishes to install the software into his PC hard disk. The default is :

"C:\Program Files\CHICALEP "

User may change this path if wishes to do so.

Uninstallation

In order to uninstall the CHICALEP software from the user's PC, perform the following:

1. Click on the **Start** button.
2. Choose **Programs** from the pop-up menu.
3. Drag the mouse to the right and click on **CHICALEP** from the list.

4. Click on **Remove CHICALEP** and follow the onscreen instructions to uninstall CHICALEP software.

Or

1. Go to the **Control Panel.**
2. Choose **Add/Remove Programs**.
3. Select **CHICALEP** from the list.
4. Click on **Add/Remove** button and follow the onscreen instructions to uninstall CHICALEP software.

Other Requirements

The following files are required and installed to run CHICALEP:

a) Macromedia Flash Player 7.0 ActiveX Control (Flash 7.0 ActiveX Control.exe).

b) Visual Basic 6.0 Runtime files (VB Runtime Service Pack 5.exe).

These two files can be found on the CHICALEP CD-ROM together with the setup file of CHICALEP in the **Installer** folder.

CHICALEP User Manual

Startup Splash Screen

Before starting CHICALEP System, make sure that the Chinese Star program is activated first. After user double-clicks on the CHICALEP icon displayed on desktop, the System will show up a startup screen, as shown in Figure 1.

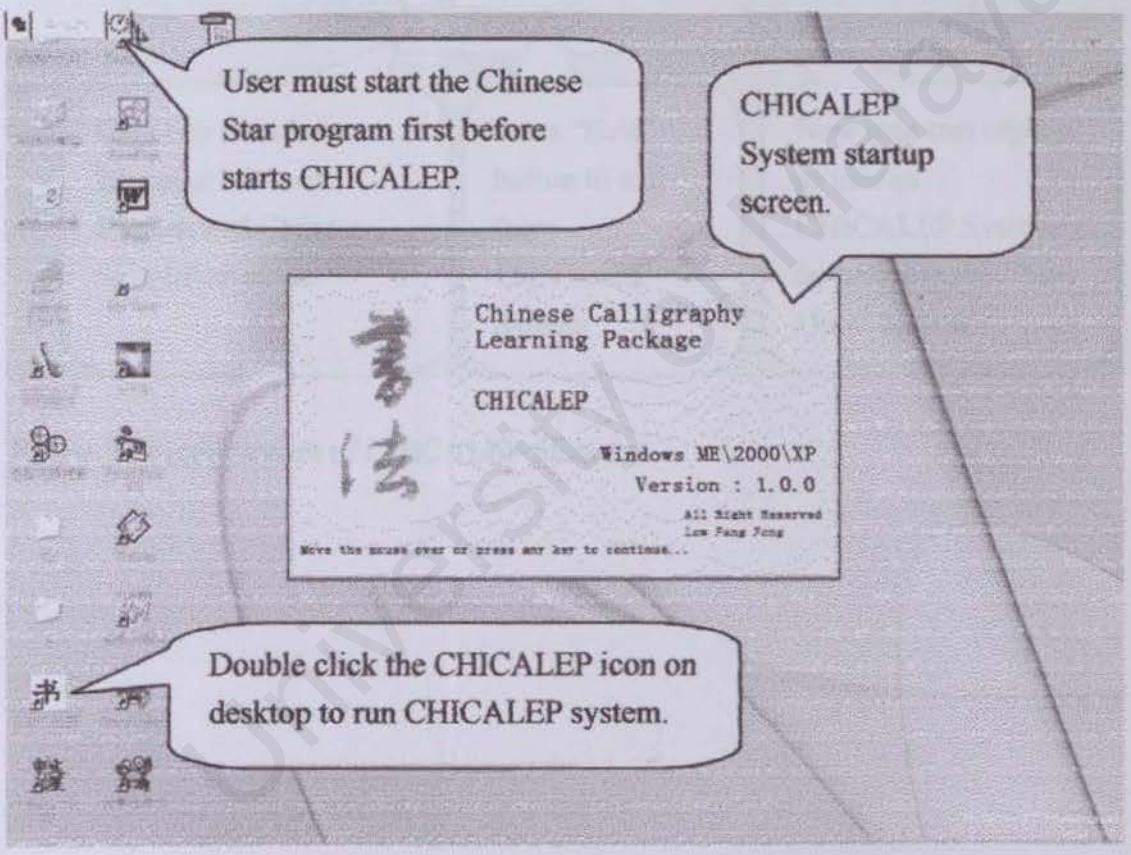

Figure 1 : Startup screen of CHICALEP system

Login Screen

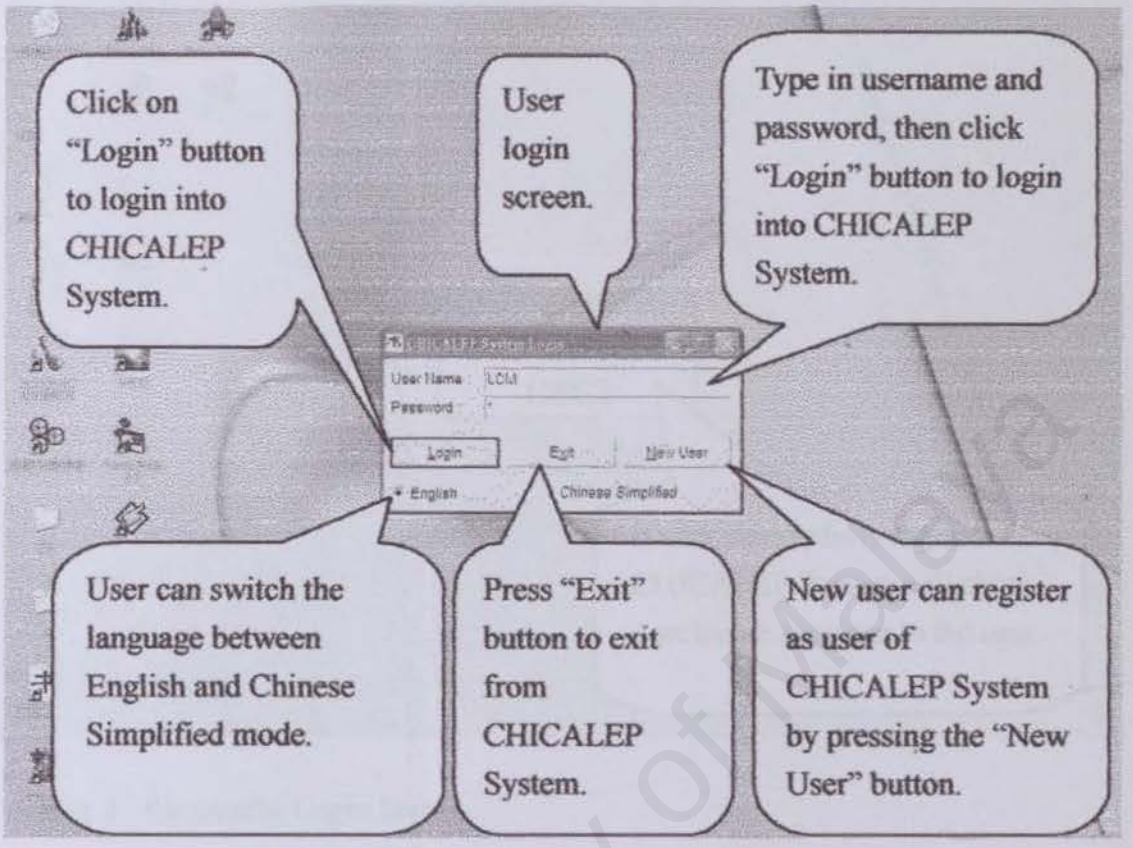

Figure 2 : Login Screen of CHICALEP System.

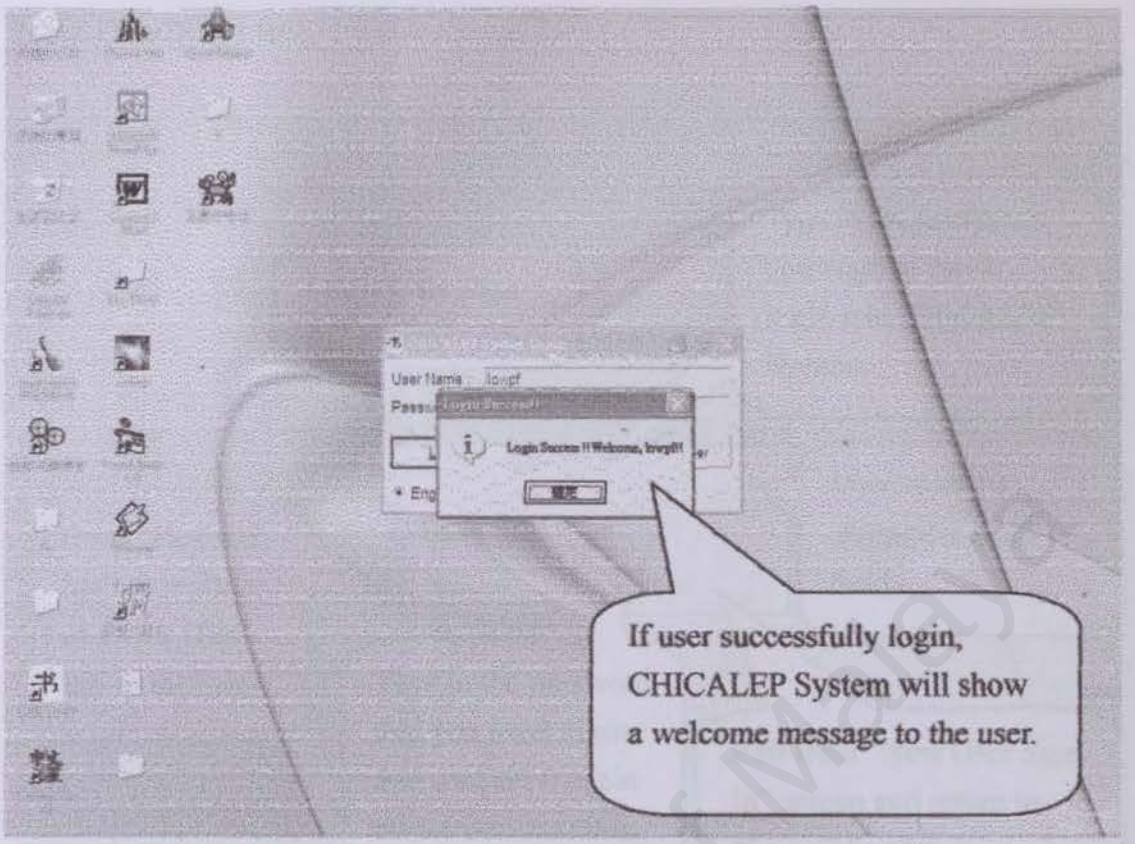

Figure 3 : Successful Login Screen.

New User Sign In

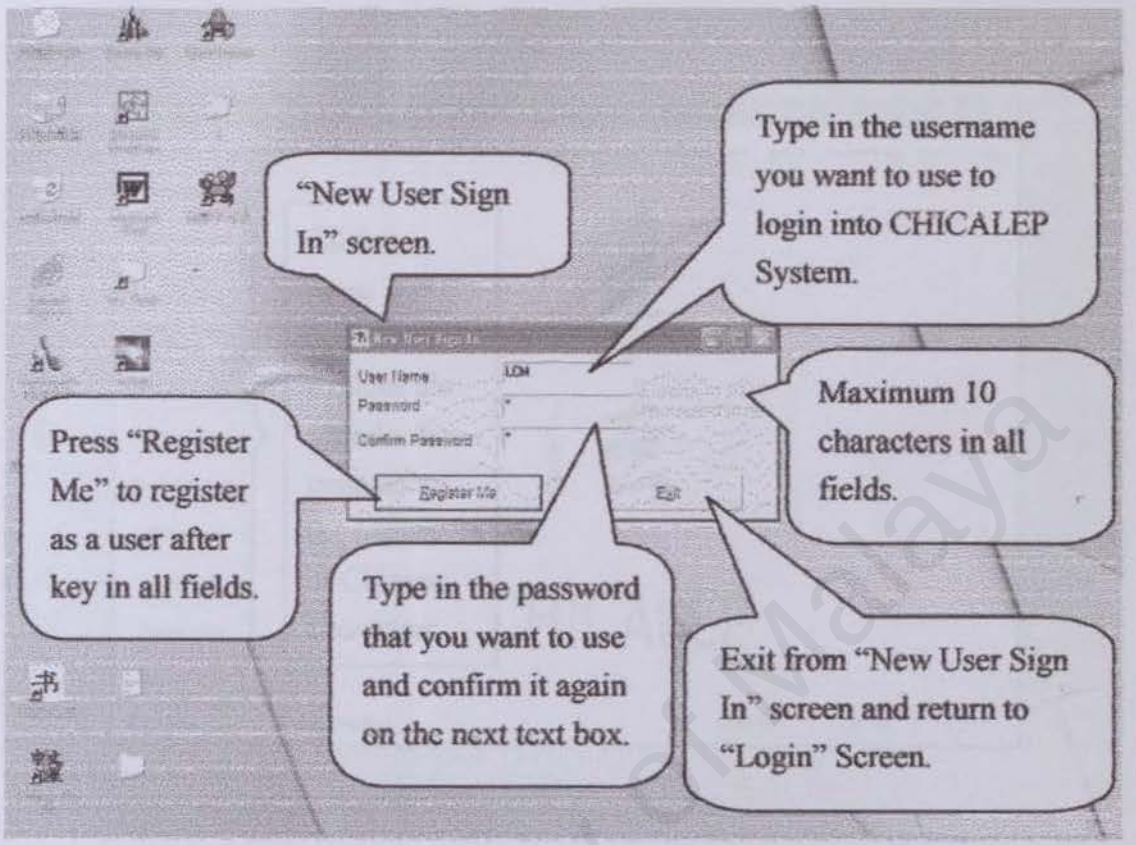

Figure 4 : New user sign in screen.

After user types in his username and password, he can then register by pressing the "Register Me" button. The chosen username must not have been used by other user.

Introduction Screen

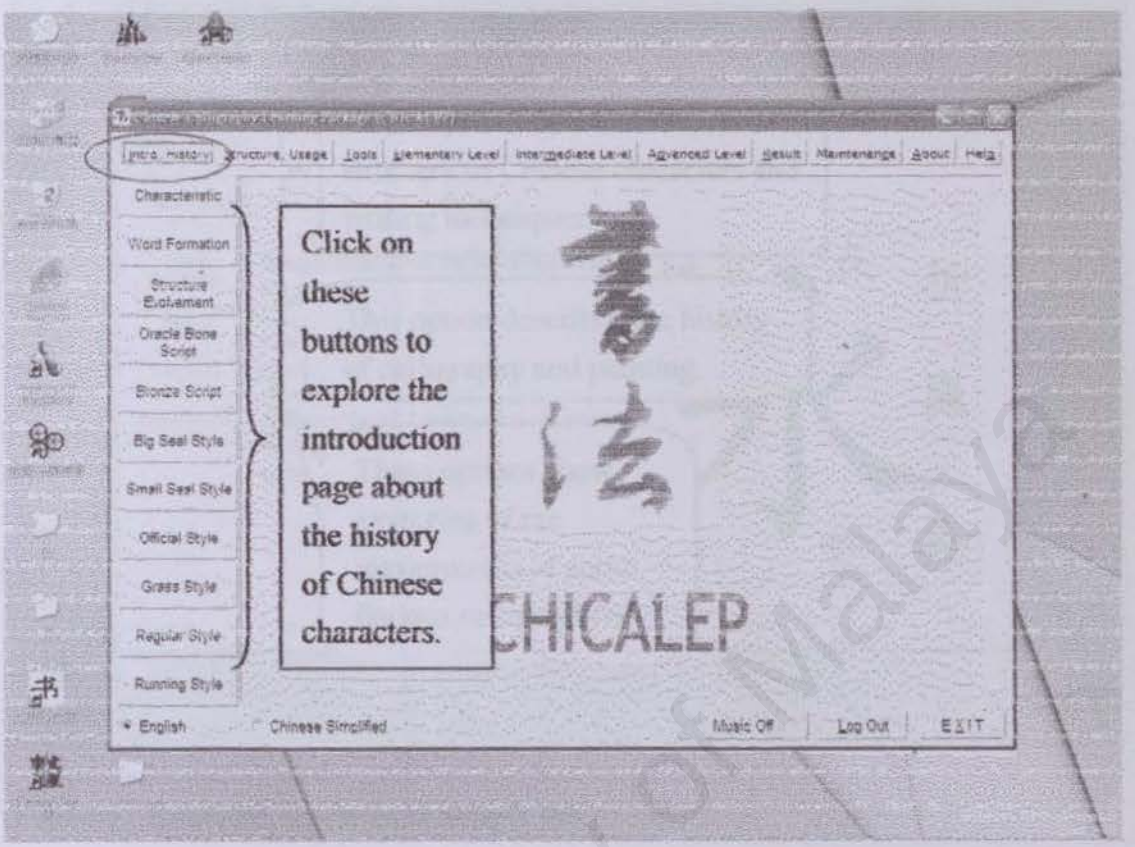

Figure 5 : Introduction and history tab.

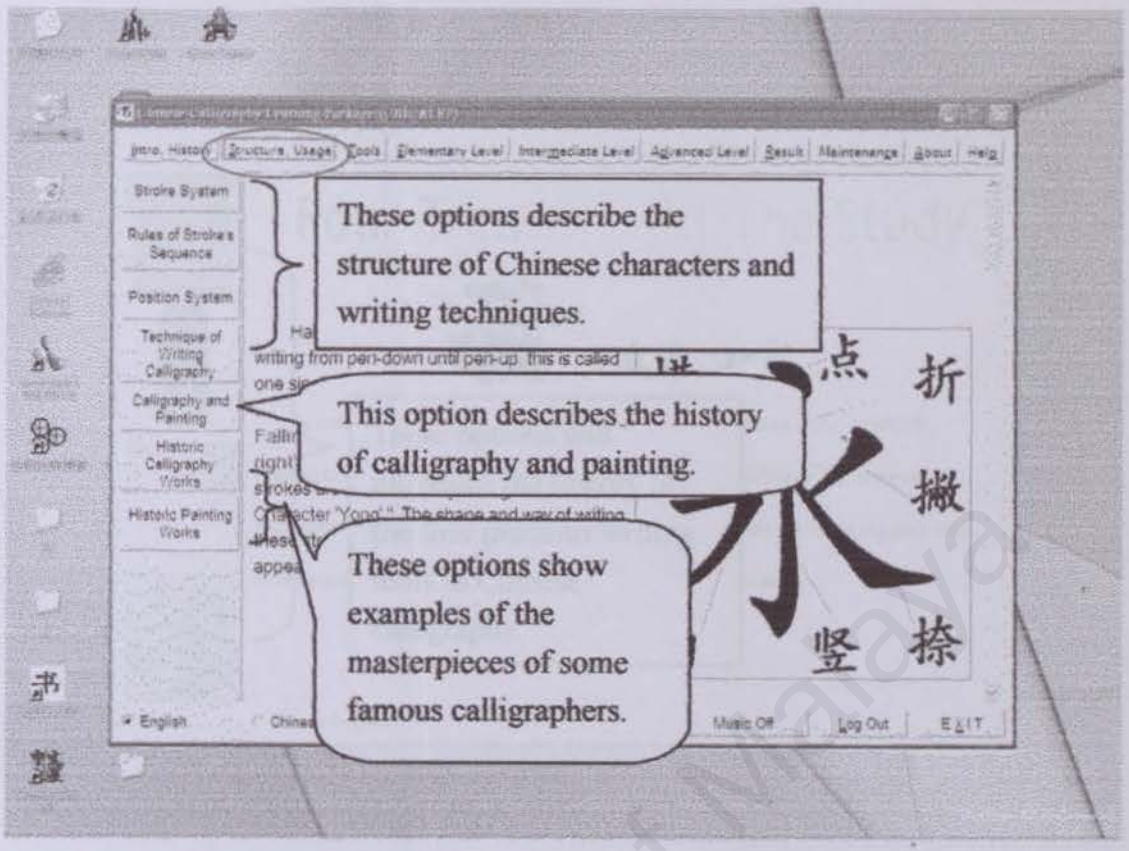

Figure 6 : Structure, usage and example tab.

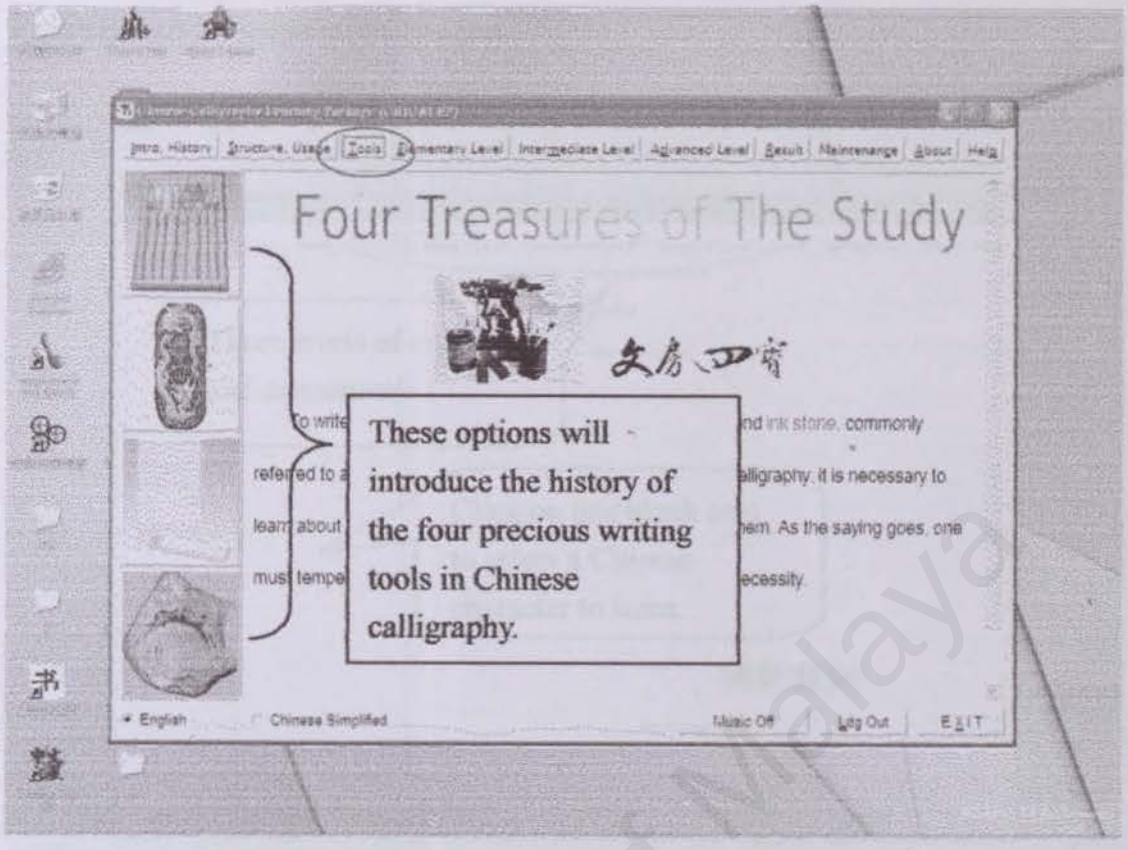

Figure 7 : Tools tab shows the four precious writing tools in Chinese calligraphy.

Exercise and Assessment Screen

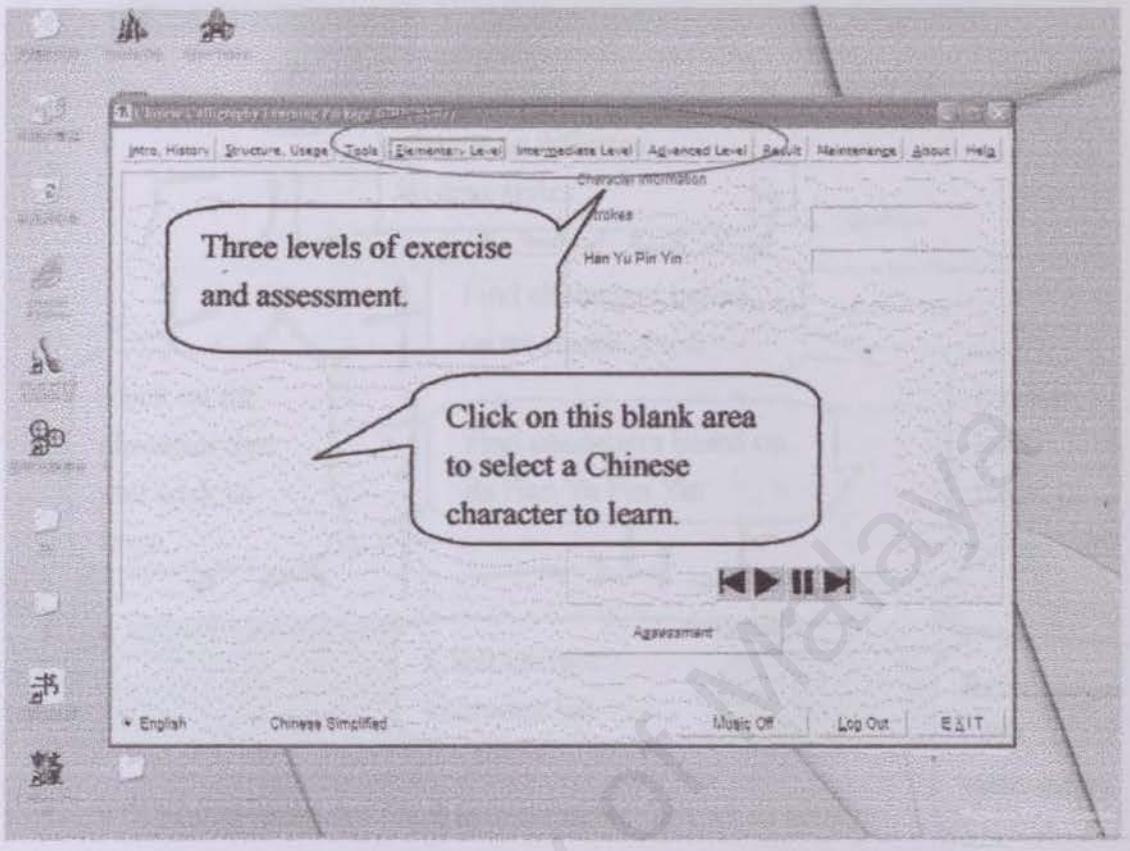

Figure 8 : Exercise and assessment tab.

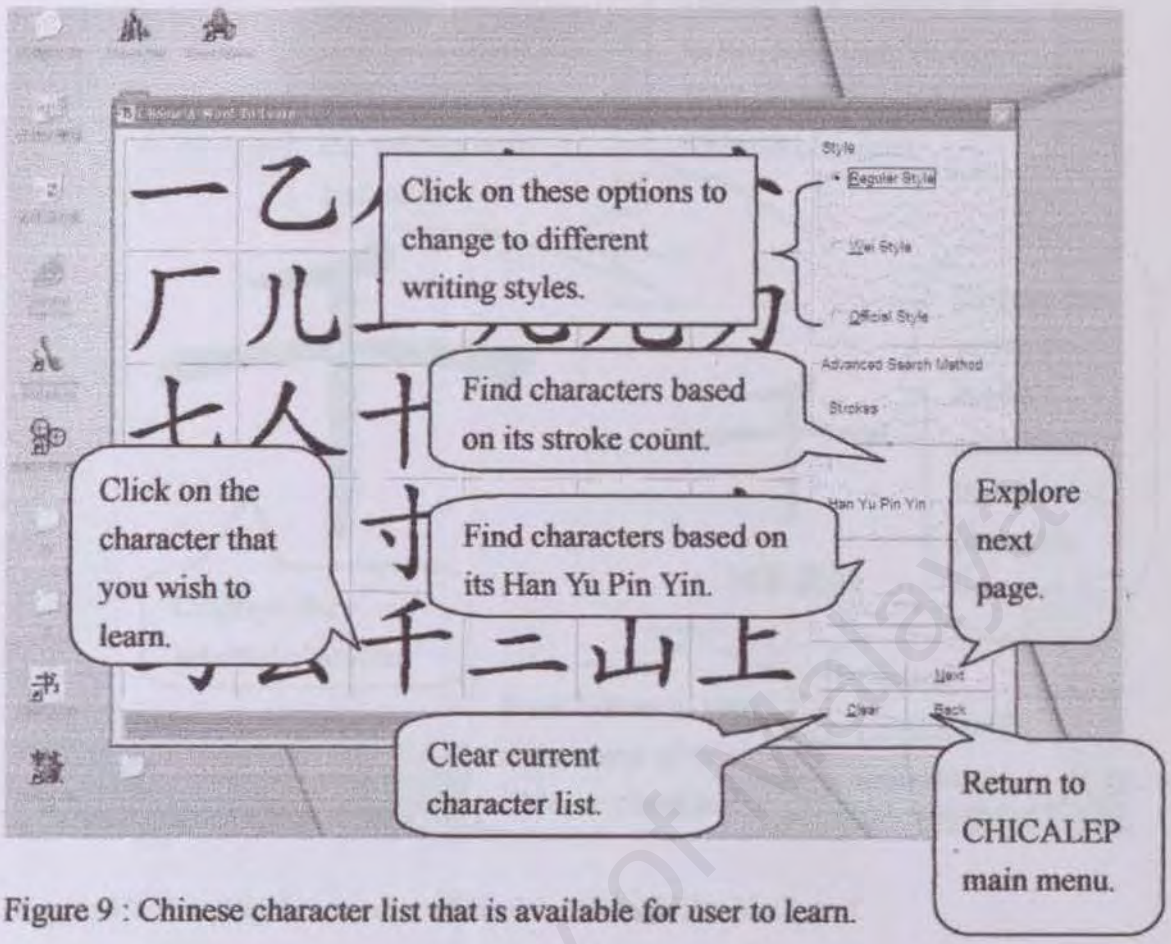

Figure 9 : Chinese character list that is available for user to learn.

How to find a character using its Han Yu Pin Yin :

Table 2 : The Four Chinese Pronunciation Tone of Chinese Character

Tone	Description	Example Character	Alphabet used in CHICALEP
¯	High and level tone	夫 fū	fu01
´	Rising tone	扶 fú	fu02
ˇ	Fall-and-rising tone	辅 fǔ	fu03
`	Falling tone	复 fù	fu04
	Light tone	咐 fu	fu00

For example: Han Yu Pin Yin for the Chinese character "书" is "shū". User can type "s", "sh", "shu", or "shu01" to find this character.

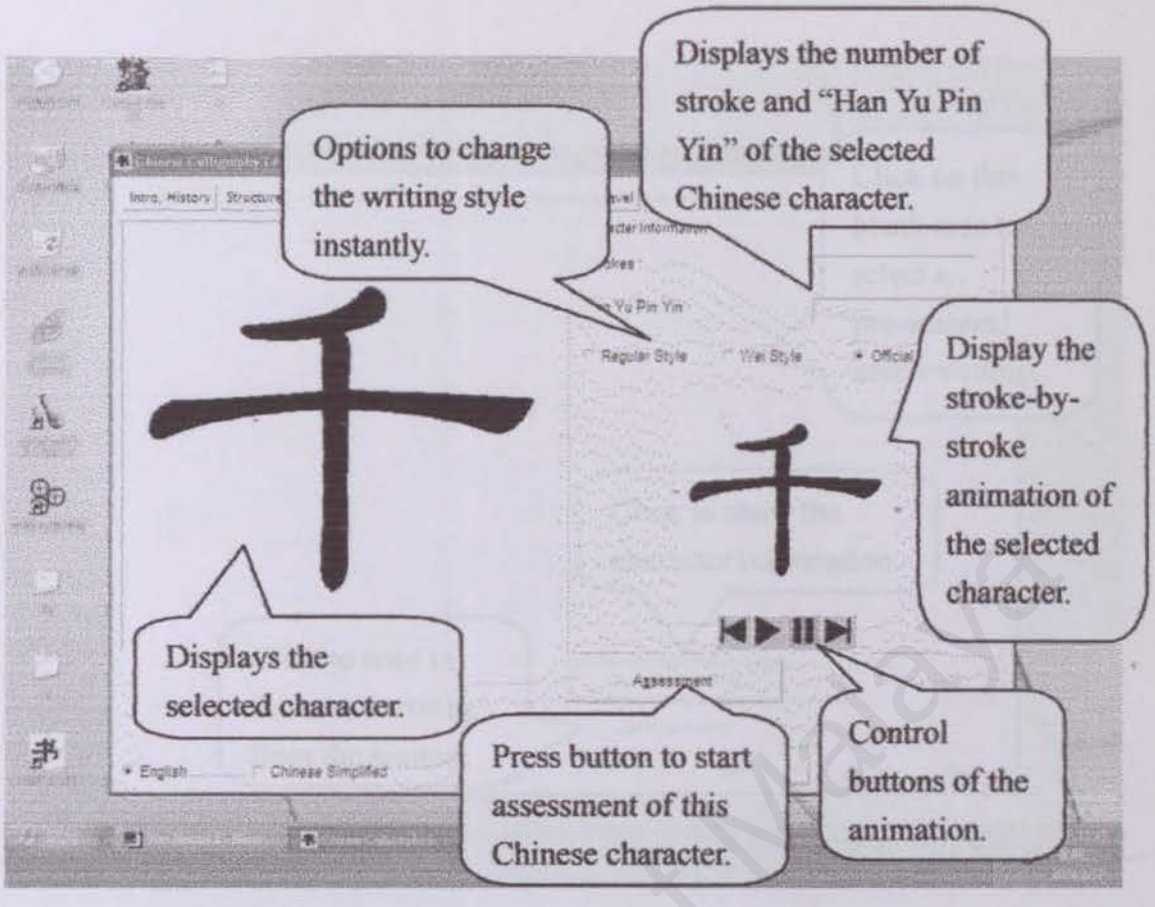

Figure 10 : Display the number of stroke, "Han Yu Pin Yin", and stroke-by-stroke animation of the selected Chinese character.

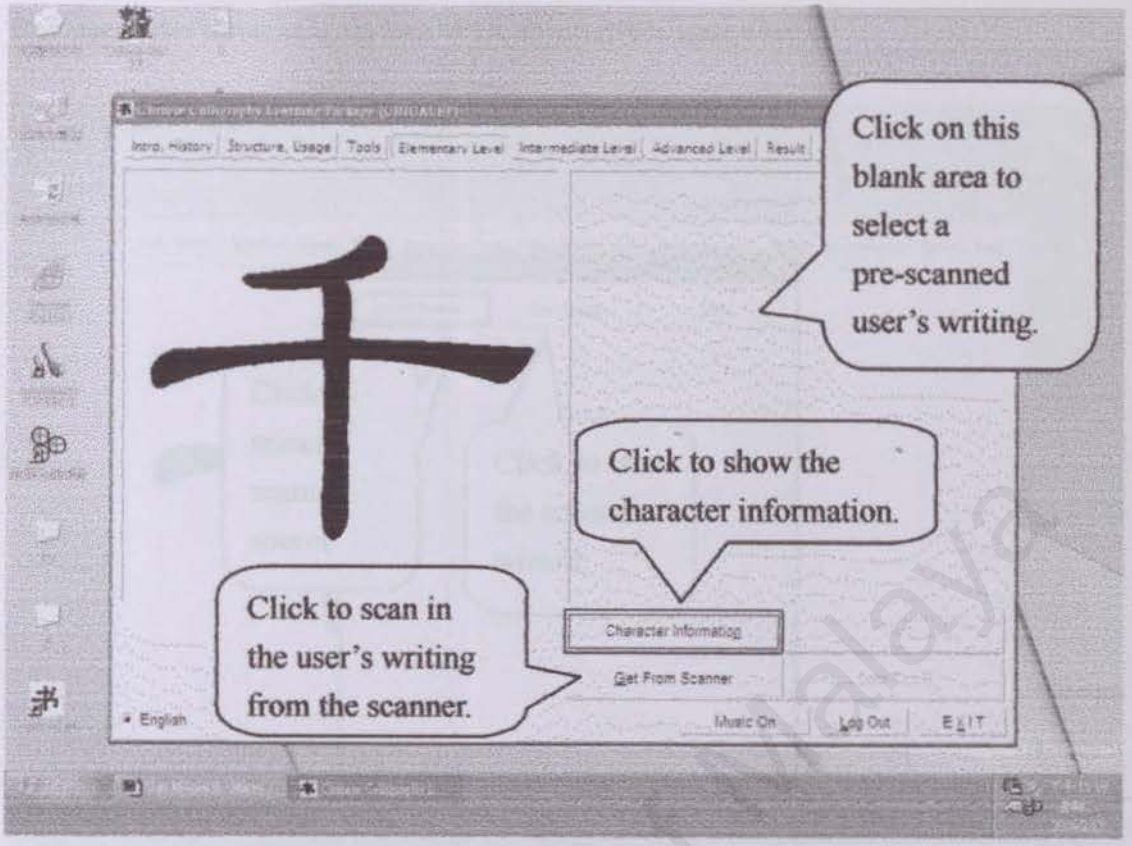

Figure 11 : Assessment screen of the selected Chinese character.

For user who have at least one WIA compatible scanner:

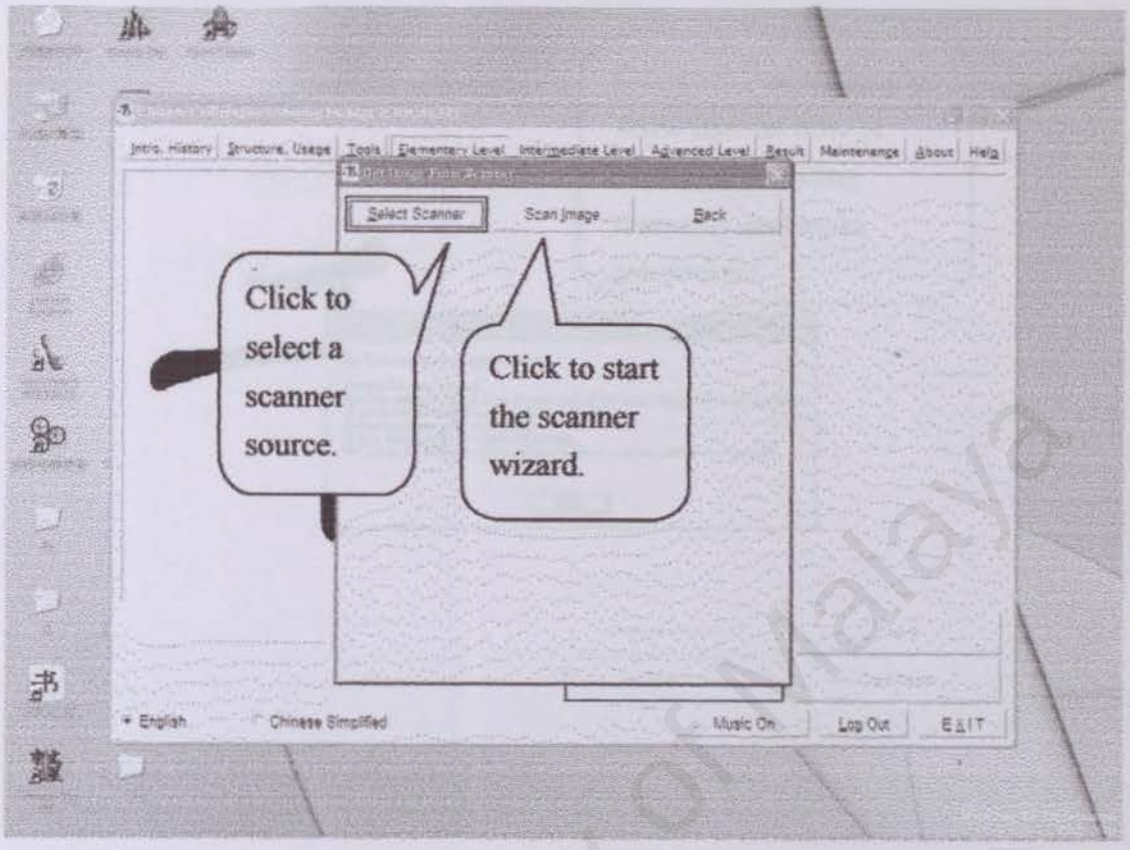

Figure 12 : Get image from scanner screen, for user who have WIA compatible scanner.

For user who do not have a WIA compatible scanner.

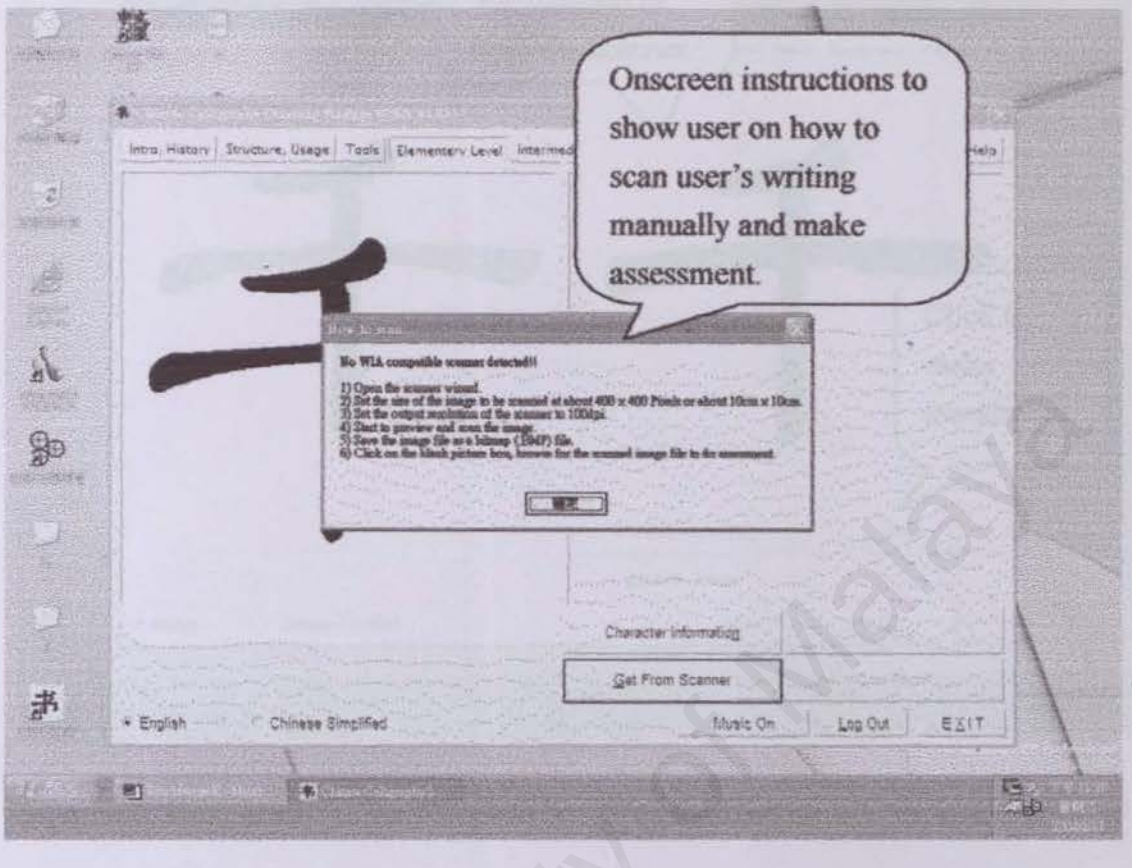

Figure 13 : Instructions on how to scan and perform assessment on the Chinese character for user who does not have a WIA compatible scanner

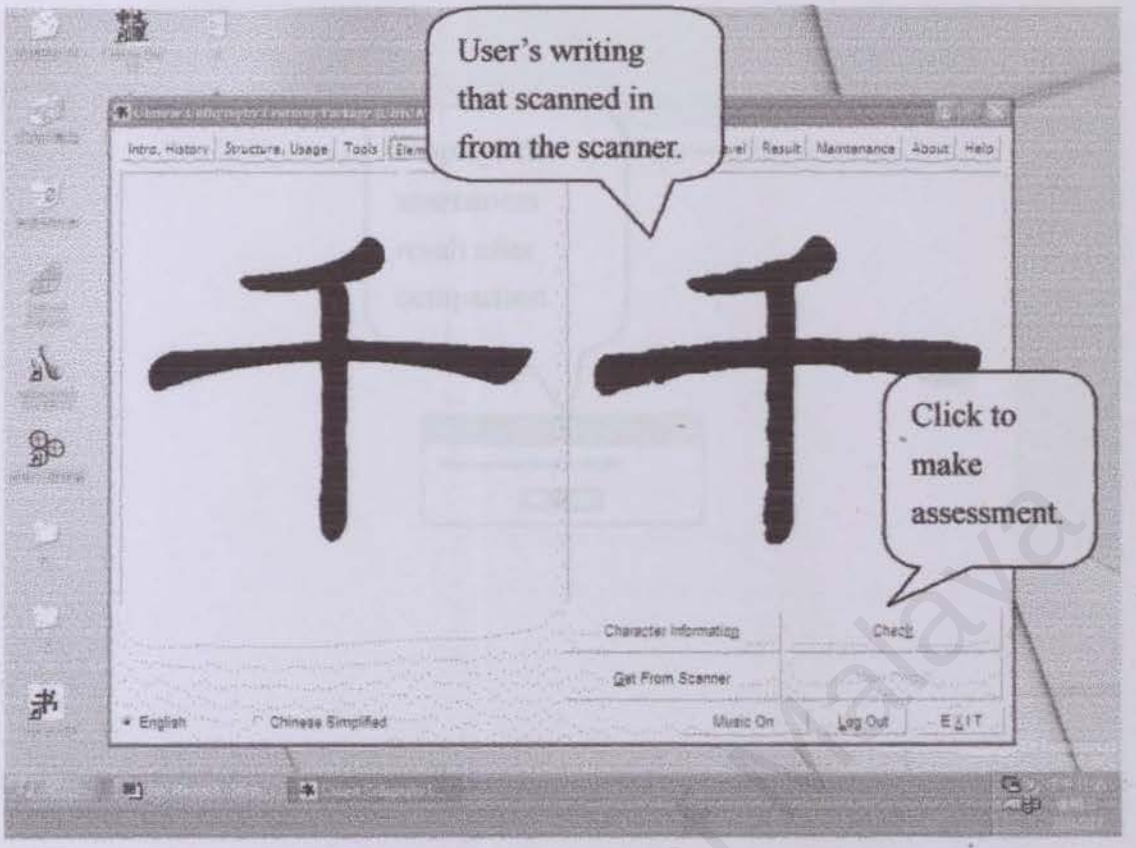

Figure 14 : User's writing has been scanned from the scanner.

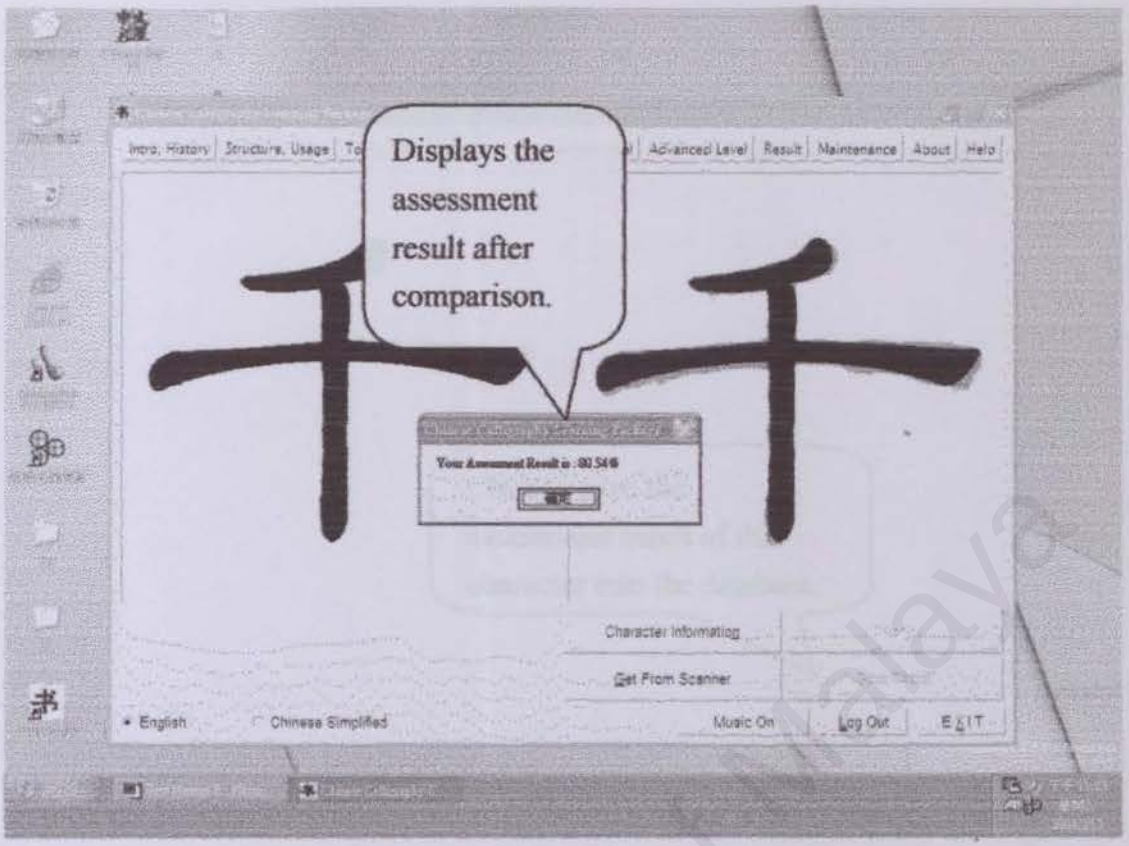

Figure 15 : Display the assessment result.

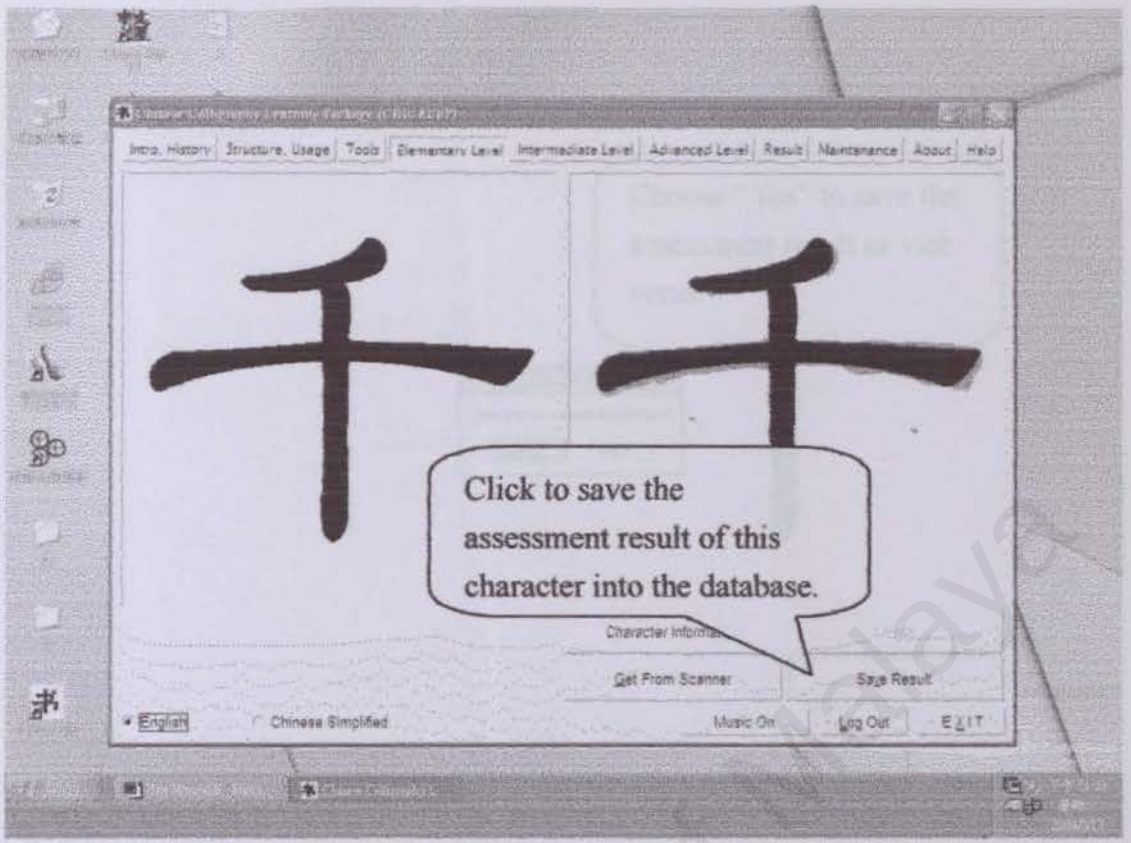

Figure 16 : Save the assessment result.

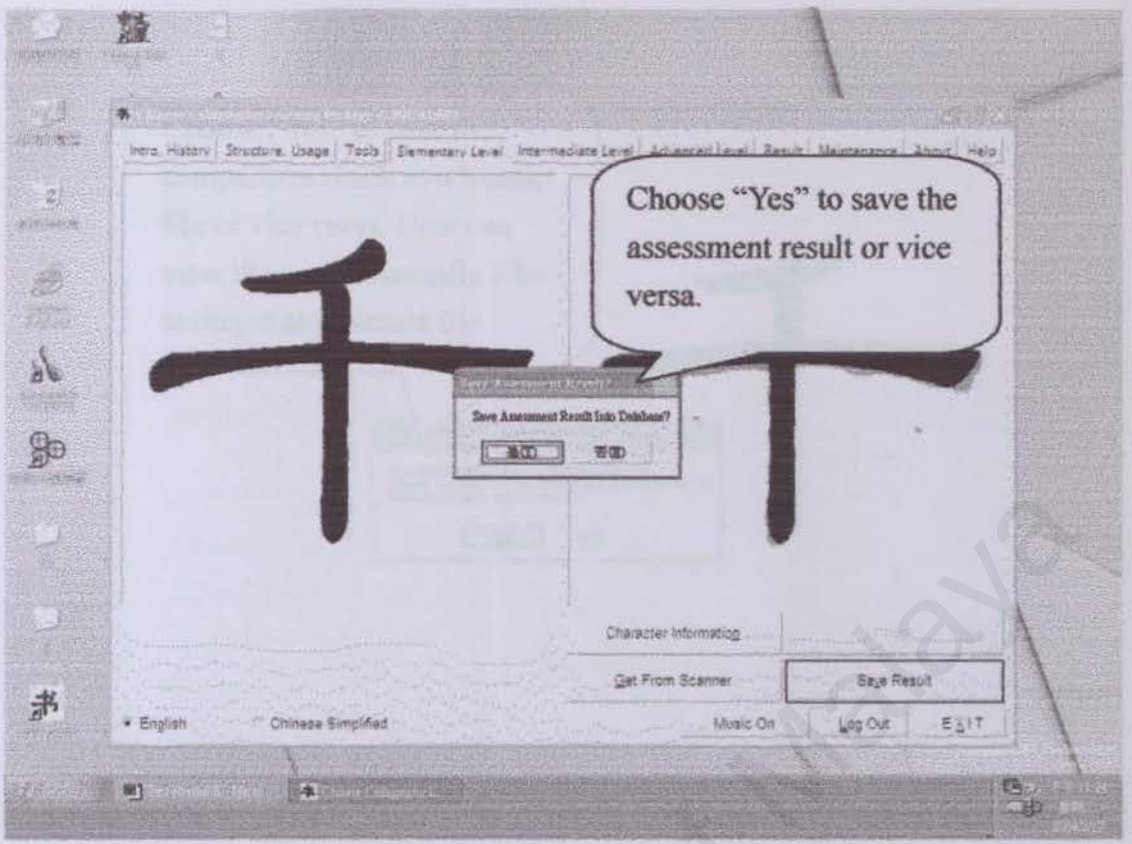

Figure 17 : Save the assessment result into the database.

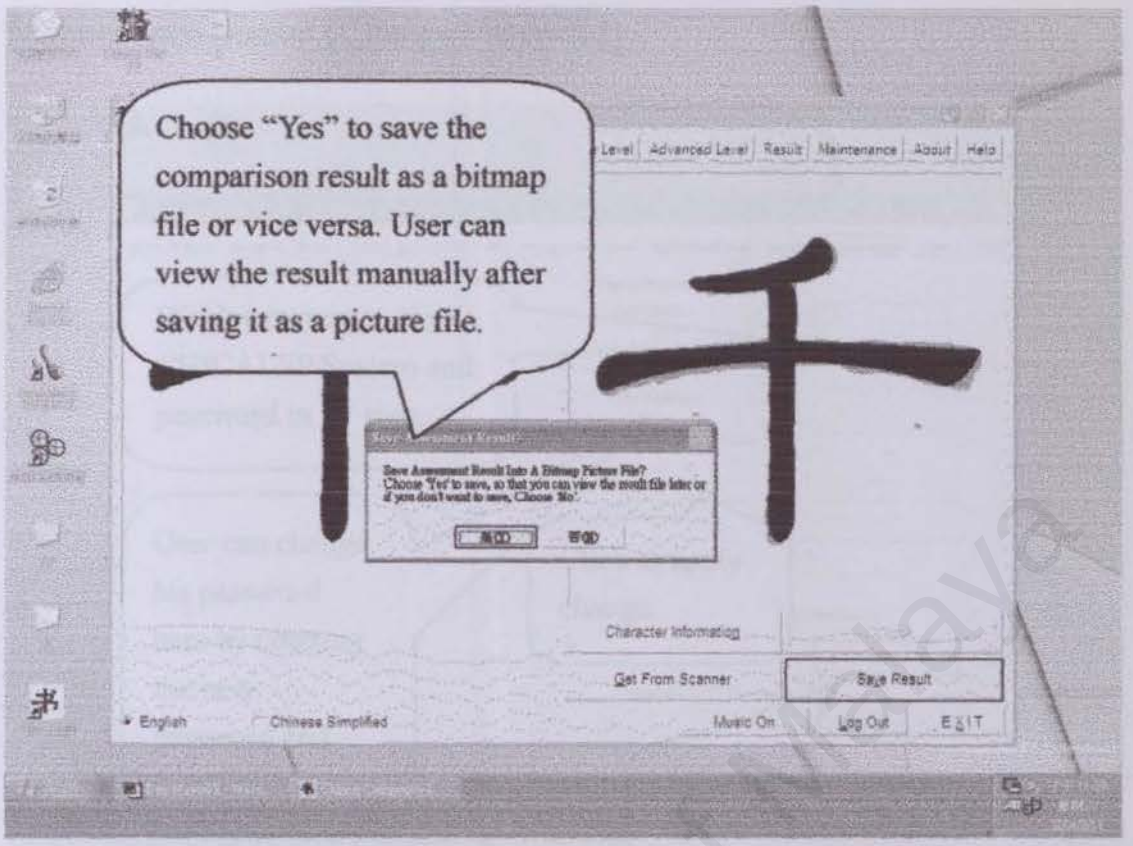

Figure 18 : Save the comparison result as a bitmap picture file.

Maintenance Screen (Change Password)

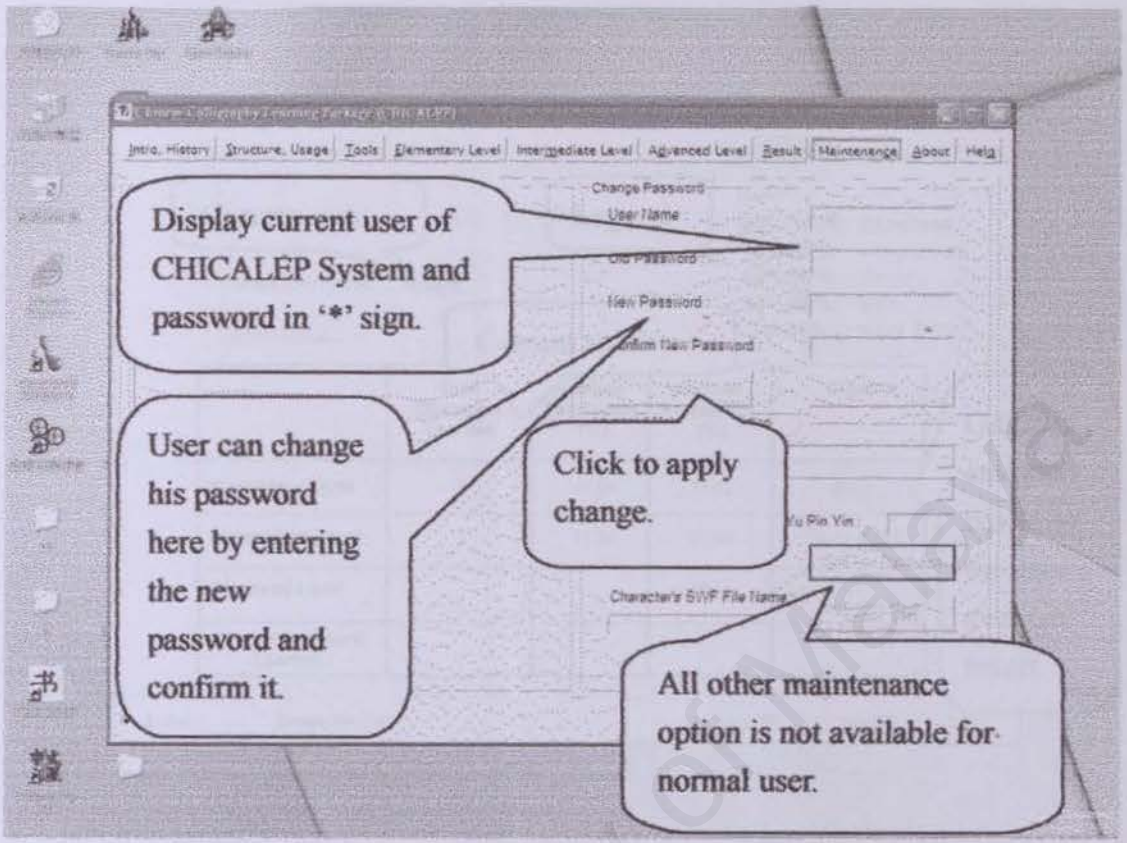

Figure 19 : Maintenance screen to change password.

Result Screen

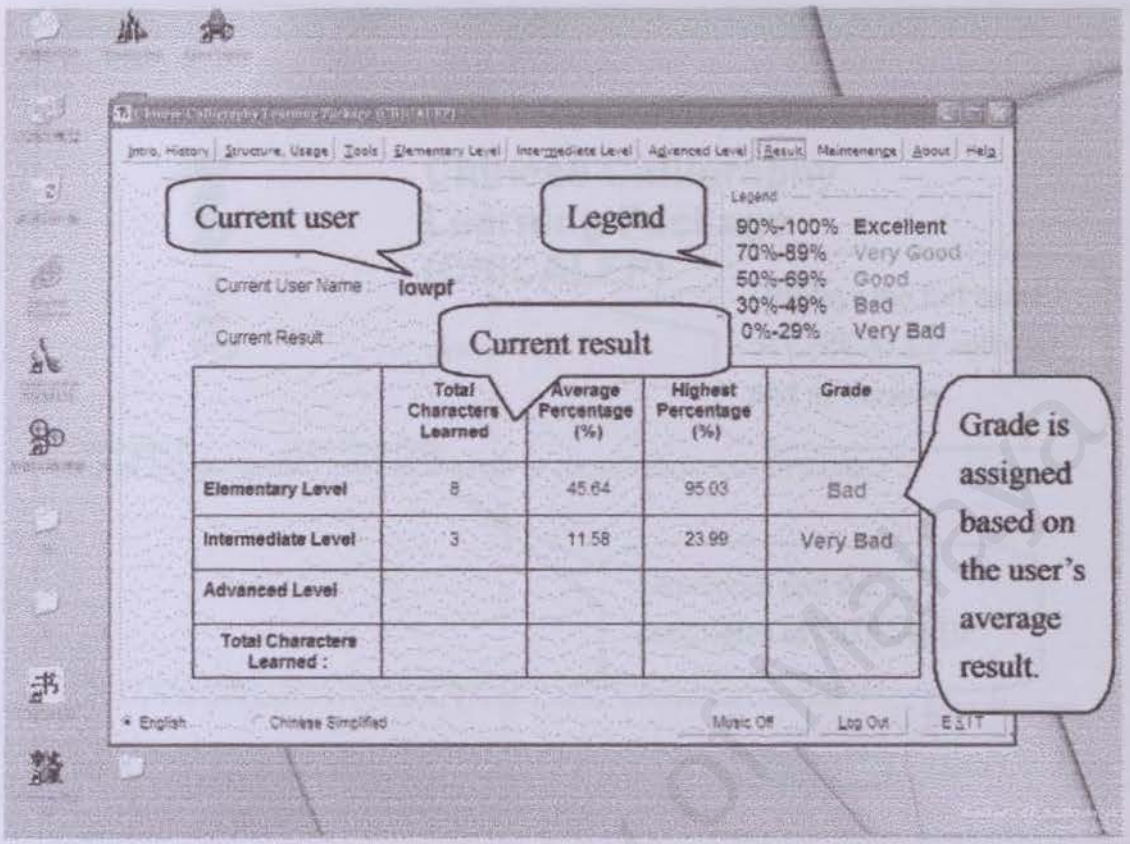

Figure 20 : Display the current assessment result of the user.

About Screen

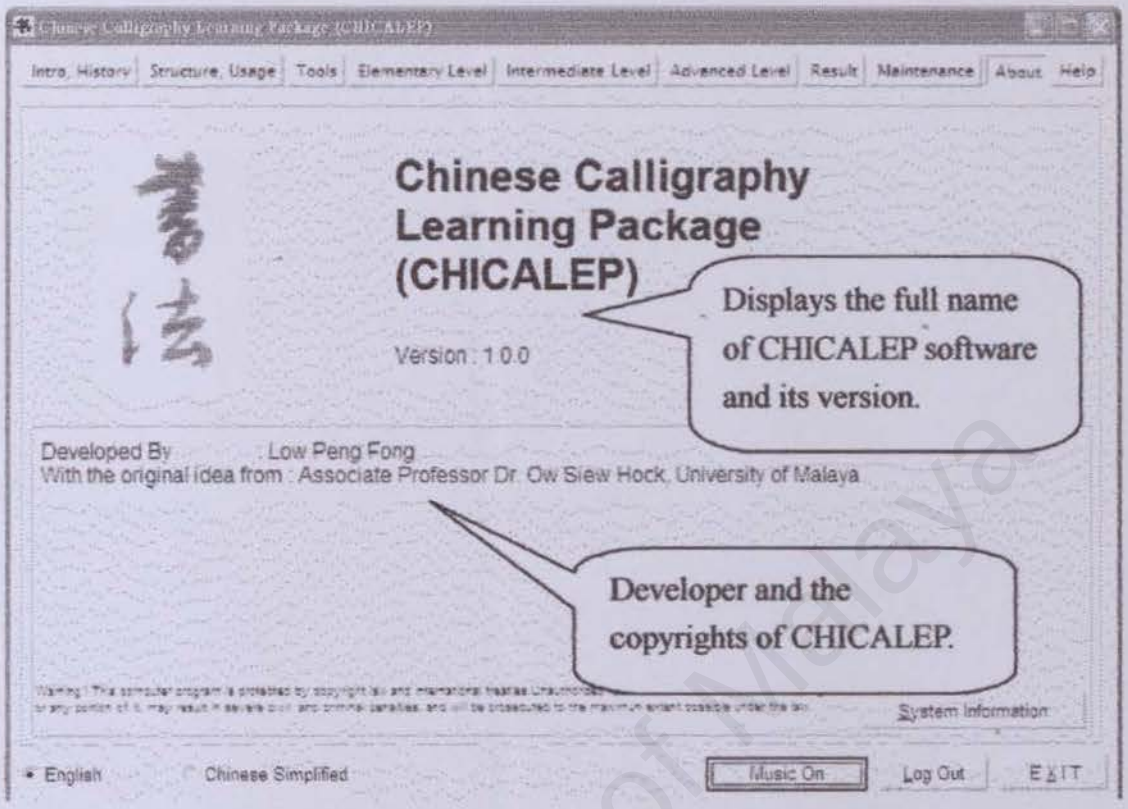

Figure 21 : About CHICALEP.